THE DUODENAL TUBE;-

ITS USE IN DIAGNOSIS AND TREATMENT.

by

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HISTORICAL.

The history of the duodenal tube may be said to date back to a period following the discovery of the stomach-pump by Kussmaul.

Physicians, recognising the importance of the information to be obtained from examination of the gastric contents, were anxious to investigate the secretions of the other organs of digestion, and Boas, in the year 1889, was the first to publish a paper in which he claimed to have discovered pancreatic secretion in the fluid regurgitated into the stomach from the duodenum.

His observations and investigations, however, in common with those of other writers such as Volhard, were really of very little clinical importance as the regurgitated fluids, on examination, were invariably mixed with the gastric secretions.

Hemmeter, in the year 1897, invented an apparatus consisting of a rubber bag somewhat resembling the stomach in shape which, when distended with air,

permitted the passage of a tube into the duodenum, and he claimed to have obtained, by this method, specimens of fresh pancreatic secretion. His method, however, was open to the objection that stomachs vary in size and shape, and he himself one year later, discarded the apparatus after the publication of Kuhn's paper. The latter's method consisted in the introduction into the stomach of a metal spring which was then pushed along until it passed through or engaged in the pylorus. This procedure, however, also proved to be unsatisfactory in practice, and it was not until the year 1909 that a suitable instrument - the "Duodenal Bucket" - was devised by Einhorn.

This investigator had, for several years previously, been experimenting by passing beads attached to threads through the stomach and intestines. In the course of time he found that he could pass a fine catheter over one of these threads as it lay in the stomach and duodenum, and, in this way, was able to aspirate the duodenal contents.

Very shortly afterwards he improved on his technique by passing a rubber tube without the guiding thread, into the stomach and allowing the latter, by its peristaltic movements, to introduce the tube through the pylorus. This rubber tube was provided with a perforated bulb attached to its distal end. He

demonstrated this method, for the first time in public, at a medical meeting held in New York on the 11th of November 1909, and it was from this instrument that the modern duodenal tube has been evolved.

A DESCRIPTION OF THE DUODENAL TUBE.

The duodenal tube consists of a length of rubber tubing, with a diameter approximately equivalent to that of a No. 6 rubber catheter, and slightly more flexible than the latter. I have found it very desirable that the tubing should be seamless, otherwise, should the tube become choked while in situ, and efforts be made to remove the obstruction by forcing either water or air down, it is very liable to "blow out" at some point in the seam.

To the distal end of the tube a small silver nozzle is attached which, in turn, consists of two parts - a proximal and a distal. The latter is screwed into the former so that the two parts can be easily taken apart for cleaning purposes. The distal part of the nozzle is perforated by several find apertures so that it resembles somewhat a watering-rose. Each aperture is sufficiently large to permit the passage of a medium sized pin. The proximal part of the nozzle is provided with a collar over which the end of the

rubber-tubing is passed and to which it is attached by several strands of thread. Care should be taken in attaching the nozzle to see that the rubber-tube is pushed sufficiently far on to allow of one-eighth of an inch of it being folded back in such a manner that it will cover the thread, and so protect it from the action of the gastric or intestinal juices. The total length of the nozzle is three-eighths of an inch, while its diameter is, approximately, three-sixteenths of an inch.

At a point on the tubing, twenty-four inches from the nozzle, a single circle is indelibly marked, while, at another point, thirty-two inches from the nozzle, a double circle is similarly marked. These two points indicate, approximately, the gastric and duodenal levels respectively.

THE INTRODUCTION OF THE TUBE INTO THE DUODENUM.

To introduce the tube just described, it is first lubricated with either liquid paraffin or glycerine, and the nozzle is then placed gently on the back of the patient's tongue. He is asked to swallow it just as if it were a piece of macaroni. It is essential to encourage the patient to swallow as the tube is too flexible to permit of its being pushed down. I have found that the tube passes more readily if the patient lies on his back for, in this posture, the nozzle tends to drop quickly over the fauces and, once this troublesome point has been passed, the further passage generally proceeds smoothly. Inch by inch the tubing is gently pushed into the mouth, the patient being asked to swallow after each step. Many patients prefer to carry out the entire manipulation themselves and, if the procedure has, for any reason, to be carried out daily, they become quite expert in the matter. A few mouthfuls of water will greatly assist the proceedings. More and more of the tube is swallowed until the level of the single circle marked on the tube has been reached, when the patient is turned on his right side and the foot of the bed raised six inches. The patient is now asked to swallow the tube himself, at a rate not exceeding one inch every

five minutes, until such time as the double circle on the tube is level with his lips. As the patient cannot see this mark when it is close to his mouth, it is an advantage to tie a few strands of cotton thread round the tube at this level so that he can, by feeling the thread with his lips, ascertain when the correct position has been reached.

As peristaltic action alone is relied upon for introducing the nozzle into the duodenum, it is essential that the part of the tube between the first and second marks should be swallowed very slowly so that the nozzle itself may engage at the pylorus, and not, as I have frequently seen, some other portion of the tube with the result that this passes into the duodenum while the nozzle remains in the stomach. Again, if too much tubing is lying slack in the stomach it may, owing to peristaltic action, get twisted and become tied into knots. I have actually seen a tube tie itself into three knots, one superimposed upon the other, in such a way that their bulk caused considerable difficulty, and not a few anxious moments, while the tube was being drawn up along the oesophagus. Again, I can recall a case where, after repeated efforts had failed to get the nozzle into the duodenum, an X-ray examination showed that the tube had doubled back, and that the nozzle was actually making its way back up the oesophagus. Such

mishaps are the direct result of too rapid swallowing of the last portion of the tube.

The tube should be passed into the empty stomach and, in cases where the fauces are particularly sensitive, the application of a two per cent. solution of cocaine may be helpful. Occasionally, one encounters a patient who states that he or she cannot even swallow a pill. These cases are likely to prove difficult, but I have found that, if gentle persuasion and encouragement fail, the difficulty may be got over in the following manner. A stilette, made of piano-wire, just too thick to pass through one of the apertures in the nozzle (thus avoiding any possible damage to the oesophagus or stomach), is introduced down the rubber-tube, which, being thus rendered semi-rigid, can then be gently pushed down into the stomach.

In 1914 Einhorn invented what he called a "Gastric Introducer". This consists of a whalebone stem with a small receptacle at its end in which the nozzle of the duodenal tube is placed. The whole is then pushed down into the stomach. I have tried this method but have not found it so satisfactory as the piano-wire stilette. In my experience a nervous patient, and it is only with such that this method is necessary, becomes still more nervous at the sight of the more complicated apparatus, and, if one succeeds

in passing it into the stomach, invariably vomits when the whalebone is being withdrawn and continues to do so until the duodenal tube has been ejected as well. This is obviated by using a stilette as it is hidden within the tube, and, when the former is being withdrawn, the patient experiences no discomfort whatsoever.

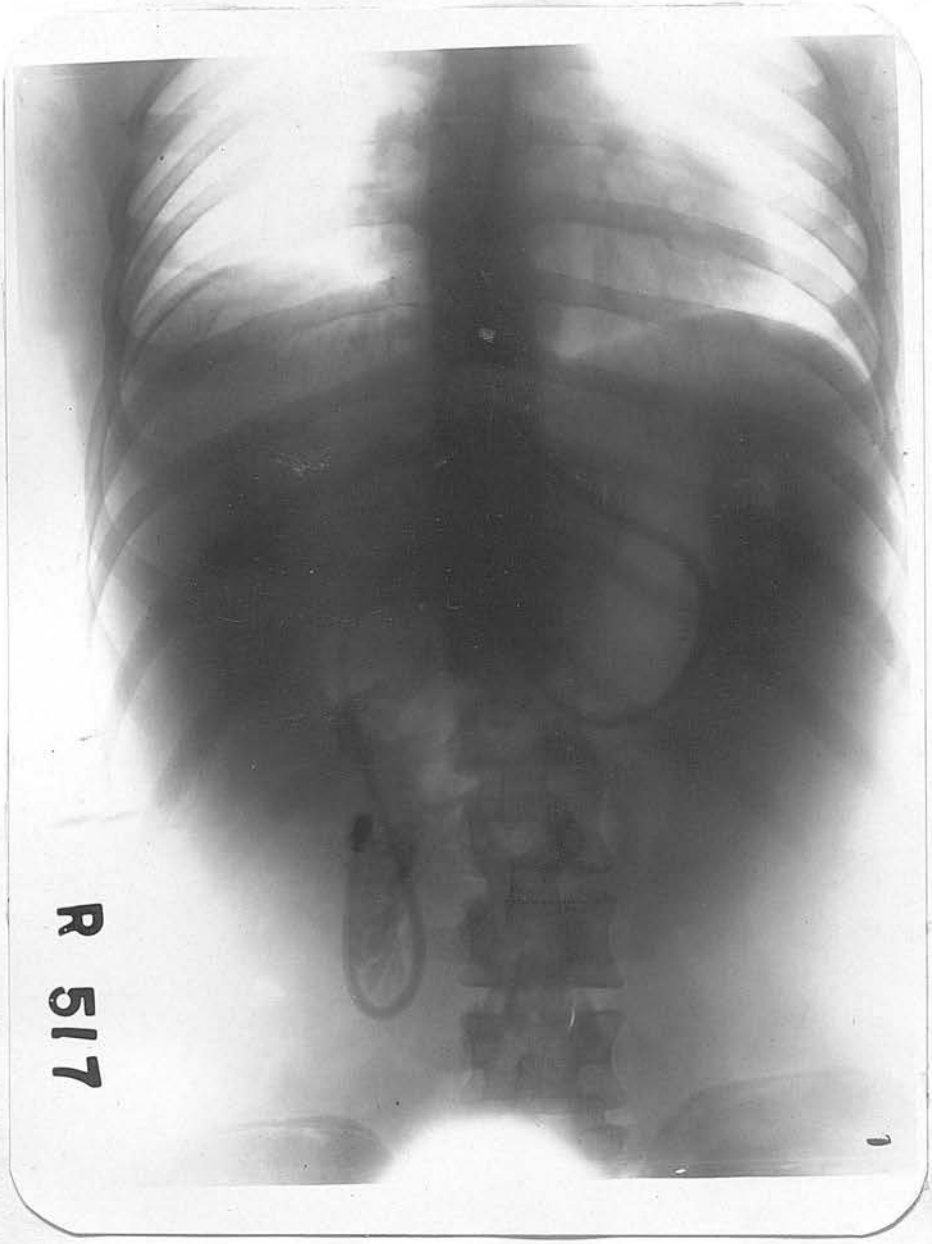
Some patients complain of nausea during the first twenty-four hours, but the administration of two drachms of ten per cent. chloretone in glycerine will relieve this.

The time which elapses before the nozzle enters the duodenum varies very considerably in different people, from a few minutes up to twenty-four hours. In the great majority of cases it is successfully in position within five hours. I have selected twenty-four hours as the maximum limit since I believe that if the tube has not passed into the duodenum within that period one is really dealing with some form of pyloric stenosis, and I can recall seven cases in which this was substantiated at a subsequent operation.

The next question which arises is this - how is one to determine that the nozzle has actually entered the duodenum? I believe the aspiration of bile to be quite useless as an indicator, for it may well be that bile has regurgitated into the stomach. Further, no reliance can be placed on the reaction of the aspirated material. In every case I make it a practice to give

six ounces of milk by the mouth and to aspirate within three minutes. If no milk is withdrawn one can be certain that the nozzle is in the duodenum. One also learns by experience the "feel" when aspirating from the duodenum, and, as a last resort, X-ray examination will show the position of the nozzle and the course of the tubing very plainly.

The X-ray print on the following page shows the duodenal tube in position. In this case the nozzle will be observed lying in a loop of small intestine. A small amount of bismuth was passed down the tube with a view to rendering it more opaque, and has passed through the nozzle into the small intestine.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THE TREATMENT OF GASTRIC ULCER BY THE DUODENAL TUBE.

One of the most interesting and beneficial uses to which the duodenal tube can be put is for the treatment of gastric ulcer.

The tube, passed in the manner previously described, is retained in position for a minimum period of eighteen days, during which time the patient is fed entirely through the tube, nothing whatsoever being taken by the mouth.

The main idea underlying this line of treatment is that by short circuiting the stomach the gastric ulcer is completely protected from the periodical passage of irritating food-particles, and, as I have discovered in many cases, from the irritating effects of the gastric juices themselves. In the table given on page 23 I present the results of a series of experiments conducted with a control-tube in the stomach. The interesting feature of these is that, after the duodenal tube has been in position for a minimum of forty-eight hours, there is a progressive diminution in the gastric acidity while, in several cases, the contents have actually been alkaline, thus providing ideal conditions for the healing of an ulcer. It is, however, quite essential, if this diminution in gastric acidity is to take place, that the food should be run

into the duodenum exceedingly slowly - at least twenty minutes being taken for an eight ounce feed. If the rate of flow exceeds this I find that gastric secretion will take place.

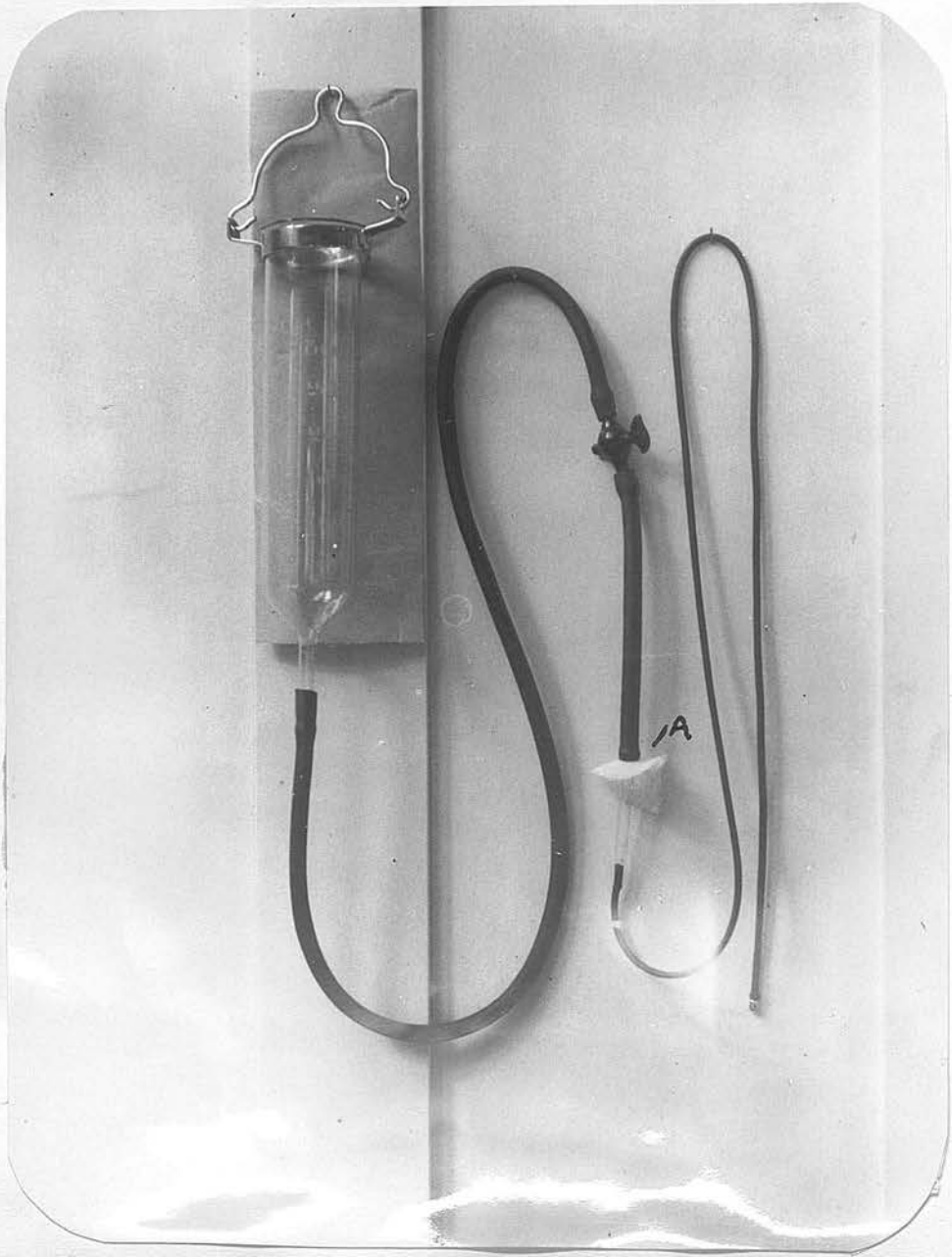
The question might be raised - is not the tube itself a source of irritation to the ulcer? I think not, for the reason that while the great majority of gastric ulcers are situated on the lesser curvature of the stomach, the tube itself lies along the greater curvature, and it is questionable if it ever comes into actual contact with the ulcer. It is worthy of note that in my whole series of cases, treated by this method, the only definite failure was in a case where the ulcer was situated at the cardiac end of the stomach and on the greater curvature. I feel certain that, in this position, the tube emerging from the oesophagus, continually rubbed against the ulcer, so causing irritation and haemorrhage, and preventing healing.

For the purpose of duodenal feeding a further length of rubber tubing, three-eighths of an inch in diameter, is required. This is attached at one end to a glass container suitable for holding the feed, the other end being joined, by means of a glass connection, to the proximal end of the duodenal tube. The food is poured into the glass receptacle, and the flow there-

from regulated by means of an adjustable tap.

A photograph of the complete apparatus is shown below.

"A" indicates a layer of fine muslin introduced for the purpose of intercepting any "skin" which may have formed on the fluid in the receptacle and which would otherwise block the nozzle of the duodenal tube.



The rate of flow should not exceed one ounce in two and a half minutes, otherwise;-

(I) The duodenum may become distended, so causing considerable discomfort to the patient.

(2) The food may leak back through the pylorus into the stomach - a condition one is particularly anxious to avoid.

(3) Secretion of gastric juice will take place.

I generally give seven to eight feeds daily at two-hourly intervals, but this may be altered to suit the requirements of the individual patient. I find the two most suitable feeds to be:-

(I) Eight ounces of milk containing one beaten-up egg.

(2) Eight ounces of Benger's food mixed with half-an-ounce of cream.

These feeds are best given alternately, and with the following additional precautions:-

(I) The patient should lie slightly on the right side during feeds, and continue to do so for fifteen minutes thereafter.

(2) All feeds should be given at body temperature, and should first be most carefully strained through fine muslin to prevent choking of the tube. Further, I have made it a routine procedure to insert a thin layer of muslin over the end of

the glass connection joining the two tubes, as this catches any "skin" which may have formed on the milk in the glass receptacle.

(3) The glass containing the feeds should be hung at a height not exceeding three feet above the bed.

(4) In order to keep the duodenal tube clear, and wash out any mucus which might be lying in the nozzle, ten c.c. of warm water should be injected down the tube previous to each feed, while, after each feed, double that amount should be slowly injected and followed by a ten c.c. syringeful of air.

(5) The feeding apparatus must be cleansed in cold water after each feed.

(6) Between meals, a small plug should be inserted in the proximal end of the duodenal tube in order to prevent leakage and soiling of the patient's clothes.

It will be seen that the above diet provides ample nourishment, the number of calories consumed in the twenty-four hours being approximately 1,700.

I have been frequently asked, when demonstrating this treatment, if patients ever bite through the duodenal tube, and I can only say that I have never seen

this happen, nor has the tube ever been frayed or marked by the teeth.

On occasion, one meets with a patient who cannot tolerate milk, and in such cases any other liquid foods, such as clear soups, beef juice or extract, and fruit juices may be substituted. I have found that generally the appetite is good, that patients look forward eagerly to their meals, and experience a sense of comfort and satisfaction afterwards. Some, however, complain of a sense of satiety and, in these, the number and the amount of the feeds must be regulated to suit their comfort.

No purgative medicine should be given by the mouth but, if required, passed down the tube. I have found cascara to be very satisfactory, and I give this as a routine for the first three mornings. Thereafter I have found that, in the great majority of cases, an easy daily action of the bowels takes place without the aid of any aperient. Castor oil and liquid paraffin must be avoided as these tend to choke the tube.

There has recently been some correspondence in the "British Medical Journal" concerning the difficulty experienced in swallowing the tube and the discomfort produced so that patients could not be induced to persevere with this line of treatment. I can only say that such has not been my experience - quite the contrary. One of my earliest patients actually took an

entire apparatus with her to America so that she could treat herself if she were unfortunate enough to have a recurrence. One could not refrain from thinking that this was rather like "taking coal to Newcastle". I strongly believe, however, that the patient's confidence should first be gained by having the rationale of the treatment fully explained to him, and, in this connection, I might mention one point which goes a long way towards securing this. One is in a position to promise quite definitely that all pain will cease within forty-eight hours from the commencement of treatment. I have never known this fail to occur. The entire disappearance of pain frequently takes place within a shorter period, and is one of the most dramatic results of this treatment; due entirely, I believe, to the absence of irritation caused by food coming into contact with the ulcer.

The duodenal tube is kept in position for a minimum of eighteen days, but occasionally longer if the primary X-ray examination has disclosed a particularly bad ulcer, or the patient's symptoms are unusually severe. The maximum is twenty eight days. Should the treatment be carried on after the eighteenth day, I consider it desirable to change the tube, but is is surprising how clean and fresh it remains, and of what little discomfort the patients complain. The throat occasionally tends to become a little dry, and all my

cases have a gargle or spray of glycothymoline, at their bedside, to be used when required.

During the course of treatment it is not necessary, as a rule, for the patient to remain in bed after the first week; many take exercise regularly, and actually go out of doors with that part of the tube which protrudes from the mouth looped over the ear. They must, however, always lie down for their feeds.

After the removal of the tube, it is necessary, owing to the diminished gastric secretion, to put the patient on a very restricted diet for the first three days, and I generally give nothing but milk in small quantities, and that at frequent intervals.
Thereafter the following diet gives satisfactory results:-

DURING THE FIRST WEEK.

One tumblerful of hot water to be sipped slowly one hour before breakfast.

Breakfast:- One scrambled or lightly boiled egg; thin white bread and butter; one cup of China tea at the end of the meal.

11 a.m. :- One tumblerful of milk sipped slowly.

Lunch :- Steamed fish; milk pudding; half a tumblerful of milk.

Tea :- One cup of China tea; dry thin toast.

Dinner :- Breast of chicken; curds, baked custard, cornflour, or farola.

One tumblerful of hot water to be sipped slowly last thing at night.

SUBSEQUENTLY.

One tumblerful of hot water to be sipped slowly one hour before breakfast.

Breakfast:- Eggs, either lightly boiled or scrambled; cold boiled ham; toast and thin white bread and butter; China tea at the end of the meal.

Lunch :- A choice of mutton cutlets, chops, or a lean cut from a tender joint of beef; boiled potatoes (no other vegetable at present); custard, curds, or milk pudding with cream; jellies.

Tea :- Two cups of China tea; a few plain biscuits.

Dinner :- A variation of lunch.

One tumblerful of hot water sipped slowly, the last thing at night.

In this way the patient may return more or less gradually to a normal diet within a month. It is highly important, however, for him to be made to understand that, once having had a gastric ulcer, even though that ulcer be healed he may get another; that, as we are ignorant of the cause of gastric ulcer, it behoves him

to live as simply as possible on a diet which he has proved by experience to suit him. It is also essential that any septic foci such as dental caries or diseased tonsils should be removed, and that importance should be laid on the simple laws of health, especially concerning a daily action of the bowels.

ADVANTAGES OF THIS METHOD OF TREATMENT.

I believe that the advantages to be gained in the treatment of gastric ulcer, more especially when situated on the lesser curvature of the stomach, by the duodenal tube are very definite, and may be summarised as follows:-

(1) The ideal conditions necessary for the healing of an ulcer are established viz:- (a) rest of the organ; (b) the removal of irritation produced by food and the gastric juices.

(2) The patient, after the first week, remains active during the course of treatment, and is fit to go straight back to work on its completion, thus avoiding a lengthy convalescence.

(3) The steady increase in weight shown by all cases so treated, the remarkable manner in which the complexion clears, and, not least, the sense of well-being experienced by the patient.

(4) No alkalinisation of the patient.

(5) No medicines are required.

Ixod Bennett, in his book "The Stomach and Upper Alimentary Canal in Health and Disease", makes a brief reference to this method of treatment.

He says:- "This ingenious method, devised by Einhorn, has a very definite value and has been insufficiently tried in Great Britain. A small tube, such as is used in fractional gastric analysis, is swallowed by the patient and allowed to pass through the pylorus to a point some inches below the peptic ulcer. The position of the tube can be checked by the aspiration of bile, or by X-ray examination. With patience and encouragement by those around them many patients are readily able to retain the tube in this situation and may then be fed with fluids at regular intervals, thus securing a degree of rest for the lesion which is obtainable by no other means.

A few patients are too nervous and hypersensitive to be able to retain the tube at all; in others, it is difficult or impossible to make it traverse the pylorus; but, when these difficulties are not present, the method is admirable, especially in the case of extensive acute ulcers and those with deep involvement of the liver and pancreas. It is not too much to say that the operation of jejunostomy is entirely unjustified until this method of duodenal feeding has been tried and has failed".

The photograph below illustrates the feeding in progress.

EXPERIMENTS RELATING TO THE SECRETION OF GASTRIC JUICE AFTER THE INTRODUCTION OF VARIOUS FOODS INTO THE DUODENUM BY MEANS OF THE DUODENAL TUBE.

These experiments were carried out in an endeavour to prove that duodenal feeding does not, under certain conditions, stimulate gastric secretion. This is contrary to the findings of Garbat on the non-traumatic stomach, but when the following conditions were not observed I have obtained results similar to his:-

(1) The rate of flow into the duodenum must not exceed one ounce per two-and-a-half minutes.

(2) The experiments must be conducted over a considerable length of time.

(3) The necessity of the tube remaining in the duodenum throughout the whole period of the experiments thus avoiding repeated stimulation of the stomach by its passage.

The following table illustrates the average secretion and gastric response to various fluids introduced into the duodenum, under the above conditions, in five cases during a course of duodenal feeding.

Titration with 1/10 normal NaOH per 100 c.c.

In each case the amount of fluid introduced into the duodenum was eight ounces.

Fluid.	3rd day. Amount aspirated	Total acid.	Free HCl.	10th day. Amount aspirated	Total acid.	Free HCl.	17th day. Amount aspirated	Total acid.	Free HCl.
Normal Saline.	8 cc.	6	4	2 cc.	4	Nil.	6 cc.	Alkaline.	
Water with ½ gr. Pot Permang.	12 cc.	8	4	7 cc.	6	Nil.	10 cc.	Alkaline.	
Plain Milk.	20 cc.	20	8	6 cc.	4	Nil.	6 cc.	Alkaline.	
Milk with one egg.	24 cc.	24	16	8 cc.	6	Nil.	4 cc.	Alkaline.	
Benger's food.	28 cc.	26	14	10 cc.	4	2	4 cc.	2	1
Benger's food with ½oz cream	26 cc.	24	14	9 cc.	5	3	5 cc.	2	1
Oatmeal gruel.	36 cc.	40	18	22 cc.	12	6	12 cc.	8	6
Chicken soup.	27 cc.	20	14	10 cc.	12	6	8 cc.	7	5
Beef tea.	32 cc.	32	16	18 cc.	10	8	11 cc.	9	5

These experiments would appear to indicate that, if the conditions mentioned are observed, there is not only a decrease in the total amount of gastric secretion, but also a marked decrease in the secretion of acid, both total and free; further, that plain milk, milk with one egg, and Benger's food, either alone or with half-an-ounce of cream, cause the minimum of gastric secretion, and would, therefore, appear to be the ideal foods for the treatment of a case of gastric ulcer by means of the duodenal tube.

The following table shows the average results obtained from the same series of patients two weeks after the termination of duodenal feeding and is given to demonstrate the contrast in results when slow introduction of food into the duodenum is compared with rapid. In each case the stomach was emptied before the experiment began.

	Slow filling of Duodenum.			Rapid filling of Duodenum.		
Eight ounces of:	Aspirated from stomach	Total acid.	Free HCl.	Aspirated from stomach	Total acid.	Free HCl.
Milk and egg:	28 cc.	32	22	54 cc.	48	36
Oatmeal gruel:	40 cc.	40	28	96 cc.	62	42
Beef tea:	33 cc.	34	25	72 cc.	56	38

A SERIES OF CASES OF GASTRIC ULCER TREATED WITH THE DUODENAL TUBE.

Case 1. Mrs. C.H. Aged 45.
This patient was admitted to hospital in a state of collapse. She stated she had suffered from indigestion for a period of twenty years and, for the past fortnight, had been unable to retain any food. She had vomited considerable quantities of blood, complained of constant pain, and could hardly suffer the weight of the bed-clothes on her abdomen. She was too ill for either an X-ray or fractional test-meal examination. It was felt that a diagnosis of carcinoma must be considered in this case but, with a view, at least, to getting her into better condition, it was decided that she should have a course of duodenal feeding. A duodenal tube, passed four days after her admission to hospital entered the duodenum easily. Within twenty-four hours all pain had ceased and, on the second night, she slept the whole night through. Occult blood disappeared from the stools on the sixth day. The total duration of treatment was twenty-one days and she was in hospital for five weeks altogether. During this period she gained seven pounds in weight. Shortly afterwards she left for America, and two years later she wrote to say she was in perfect health.

Case 2. Miss E.E. Aged 38.
This patient complained of indigestion extending over the past six years. The symptoms had become more severe during the last year and, for the past fortnight, she had vomited blood on several occasions. She had observed that her motions were frequently black. X-ray examination showed a small ulcer on the lesser curvature close to the pylorus and, a fractional test-meal examination was also suggestive of gastric ulcer. A duodenal tube was passed and treatment continued for twenty-one days. Occult blood disappeared from the stools on the fifth day. She improved very rapidly and was kept under close observation for a period of six weeks. During this period she gained twelve pounds in weight. X-ray examination at the end of treatment showed no evidence of any ulcer. She has reported herself frequently but has had no recurrence of any symptoms over a period of fifteen months.

Case 3. Mrs. C.C. Aged 31.
Had suffered from indigestion with frequent attacks of vomiting for four years. She had endeavoured to carry on, but six months ago was compelled to give up her work. She complained of severe pain which was always related to the taking of food. She was very emaciated and anaemic. X-ray examination showed an ulcer about the middle of the greater curvature of the stomach but the fractional test-meal was not suggestive of gastric ulcer. The stools contained occult blood. A duodenal tube was passed and entered the duodenum very easily. All pain had ceased within twenty-four hours, and no occult blood was found in the stools after the fourth day. Treatment was continued for twenty-one days, during which period her progress was most striking. X-ray examination at the end of treatment showed no signs of ulcer and her fractional test-meal curve had assumed a very much more normal appearance. In eight weeks from the commencement of treatment, she gained no less than twenty-eight pounds in weight, and has remained in good health for the past two years.

Case 4. Mr. J.N. Aged 44.
This patient had suffered from pain and vomiting after food for three years. His symptoms had become more severe during the past fortnight. Constipation was very marked. X-ray examination showed an ulcer in close proximity to the pylorus, while fractional test-meal investigations indicated spasm of the pylorus. A duodenal tube was passed and the greatest difficulty experienced in getting it into the duodenum. Several attempts were made without success until the spasm was overcome by means of a dose of chloretone in glycerine. Bacteriological examination of the duodenal contents gave an exceedingly heavy growth of bacillus coli. Treatment was continued for a period of twenty-one days, and one of the most noticable results was the remarkable manner in which the complexion cleared, changing from a dirty, muddy colour to a healthy pink. The bowels moved daily of their own accord after the third day. He was under treatment for five weeks altogether and gained two pounds in weight during this period. For the past two years he has remained free from any gastric symptoms.

Case 5. Miss C.S. Aged 24.
This patient had suffered from indigestion for as long as she could remember. She had frequent attacks of pain coming on after food, and on one occasion had vomited blood. She was not X-rayed but fractional test-meal results along with the finding of occult blood in the stools and duodenal secretions established a diagnosis of gastric ulcer. She received a course of duodenal treatment extending over a period of eighteen days. Occult blood disappeared from the stools on the fifth day. She was kept under observation for eight weeks and, during this time, gained seventeen pounds in weight. During the past twenty-one months she has remained in excellent health.

Case 6. Mr. H.M. Aged 52.
This patient was admitted to hospital as a perforated gastric ulcer giving a history of having been suddenly seized with very severe abdominal pain four hours previously. There was a previous history of gastric pain and discomfort extending over a period of eight years. The operation disclosed a very large ulcer on the lesser curvature of the stomach with a perforation, about one quarter-of-an-inch in diameter, at its centre. Owing to the extreme friability of the surrounding tissues the greatest difficulty was experienced in closing this perforation and a grave prognosis was given as the patient's condition was very bad. A duodenal tube was passed on the second day after the operation, entering the duodenum with ease, and feeding was commenced. Rapid improvement followed but, in this case, owing to the very large size of the ulcer, it was throught advisable to continue treatment for a period of twenty-eight days. X-ray examination prior to his discharge showed no evidence of gastric ulcer. At the commencement of treatment he weighed seven stone, nine pounds, and, at the time of discharge eleven weeks later, this had increased to nine stone, four pounds, a gain of twenty-three pounds. Since then, over a period of eighteen months, he has remained well and is leading an active life.

Case 7. Mrs. C.M. Aged 61.
This patient had suffered from frequent attacks of epigastric pain and vomiting during the past eight months. She had a large haematemesis, amounting to about one pint of blood, on the day previous to admission. It was thought, at first, that she was probably suffering from carcinoma of the stomach, but on X-ray examination showing nothing more than a small ulcer on the lesser curvature not far from the pylorus, and the fractional test-meal result indicating considerable spasm of the pylorus, it was decided to give her a course of duodenal feeding. A duodenal tube was passed and there was considerable delay before it entered the duodenum. In view of her age, and the severity of her symptoms, treatment was continued for twenty-seven days. All pain had ceased after twenty-four hours, and occult blood was not found in the stools after the seventh day. She remained five weeks under treatment, gaining four pounds in weight, and X-ray examination prior to discharge showed that the ulcer had healed. She has had no return of symptoms during the past eighteen months.

Case 8. Miss E.C. Aged 24.
Gave a history of severe gastric pain for three months but would not admit any previous attacks. X-ray examination showed an ulcer on the lesser curvature, and the stools contained occult blood. The patient was very constipated. Duodenal feeding was carried out over a period of twenty days, and no occult blood was found in the stools after the fifth day. She remained six weeks in hospital, gaining five pounds in weight, and has been free from gastric symptoms during the past eighteen months.

Case 9. Mr. I.T. Aged 29.
Was admitted to hospital with a severe haematemesis which was repeated shortly after admission. There was no history of indigestion, and he was considered too ill to X-ray. Melaena was well marked. A duodenal tube was passed and feeding continued over a period of twenty-one days. On the third day the stools were normal in colour but occult blood was still present. This disappeared on the sixth day. He remained in hospital for five weeks and gained seven pounds in weight. X-ray examination at the end of treatment showed no signs of ulcer but there was a slight deformity present about the middle of the lesser curvature. He has remained in good health for the past eighteen months.

Case 10. Miss D.E. Aged 26.
Was admitted to hospital in a collapsed condition with symptoms of internal haemorrhage. She gave a history of gastric pain and frequent vomiting for one year. She was thought to be too ill to X-ray but the fractional test-meal results showed delay of relaxation of the pylorus, and the presence of blood in the stomach. A duodenal tube was passed with difficulty and feeding continued for twenty-one days. In this case the occult blood did not disappear from the stools till the tenth day. It was felt that treatment should be continued longer, but she was anxious to return to work and left hospital after a stay of six weeks, during which time she gained five pounds in weight. She has since written to say she is keeping well.

Case 11. Mr. W.S. Aged 52.
Gave a history of gastric pain for two years. Of late he had been vomiting all his food, and occasionally had brought up a little blood. He had marked dental caries, and admitted being a heavy drinker. There was a very marked family history of gastric ulcer. X-ray examination showed an ulcer to be present about the middle of the lesser curvature and the stools contained occult blood. He was given a course of duodenal treatment for twenty-one days. Occult blood was present over the first ten days, but as in the meantime he had had his teeth extracted, the positive result was probably due to this. He was discharged after eight weeks, and showed a gain of seven pounds in weight. X-ray examination at the end of treatment showed no evidence of ulceration. He has had no recurrence during the past twelve months.

Case 12. Mrs. E.M. Aged 34.
This patient had previously suffered from gastric ulcer, and was admitted to hospital with a view operation. Her general condition was very poor, and she was profoundly anaemic. She was not X-rayed as she brought her previous X-ray films with her. These showed a large ulcer to be present on the middle of the lesser curvature. The stools contained occult blood. It was felt, in this case, that duodenal feeding should be given a trial, and accordingly a tube was passed which entered the duodenum easily. The patient experienced immediate relief from all her symptoms and improved visibly from day to day. Treatment was continued for twenty-eight days, and occult blood was not found in the stools after the sixth day. She remained in hospital for six weeks, and

gained seventeen pounds in weight during this period. No evidence of ulcer could be seen at an X-ray examination prior to her discharge. She has reported on several occasions during the past eighteen months and is in excellent health. Since the termination of treatment her weight has increased by a further twenty-eight pounds.

Case 13. Mr. F.G. Aged 38.
Was admitted to hospital following a very severe haematemesis. He gave a history of epigastric pain and vomiting for many years and, lately he had vomited blood on several occasions. He had another haematemesis shortly after admission to hospital, and was critically ill, being blanched, while his pulse was almost imperceptable. In view of the severity of his symptoms I did not attempt to pass a duodenal tube for ten days but, after that period, feeding was commenced, and was continued for twenty-eight days. Occult blood was not found in the stools after the sixth day of treatment, and he improved very rapidly. X-ray examination at the end of treatment showed no evidence of ulcer, and a fractional test-meal gave a result compatible with normal. His increase in weight was striking, and was as follows:-

At the commencement of treatment	:-	8 stone	2 pounds.
On the tenth day of treatment	:-	8 stone	6 pounds.
On the twenty-first day	:-	8 stone	10 pounds.
On the twenty-eight day	:-	8 stone	13 pounds.
On discharge, (six weeks)	:-	9 stone	4 pounds.
After eight weeks	:-	9 stone	8 pounds.
After eleven weeks	:-	10 stone	7 pounds.

This shows a total gain of no less than thirty-three pounds in a little under three months.

Case 14. Mr. H.F. Aged 50.
Had suddenly collapsed in his office on the day before I saw him. He gave a prolonged history of indigestion with frequent attacks of vomiting and he had noticed that for the past three weeks his motions had been black. A fortnight was allowed to elapse before an X-ray examination took place. This showed a double ulcer on the lesser curvature. Duodenal feeding was commenced and continued for fourteen days, when the patient insisted on being X-rayed once more. This was done and it was found that the ulcer niches had very much decreased in size. The patient was so encouraged with this result that he continued

with the duodenal feeding for one month, when on further X-ray examination it was seen that the ulcers had entirely disappeared. He was quite free from symptoms and his weight had increased by eighteen pounds.

Case 15. Mr. W.F.M. Aged 33.
This patient was brought into hospital having collapsed in the street following a severe haematemesis. Shortly after admission he vomited a large quantity of blood. There was a history of dyspepsia extending over many years. He was treated by ordinary medical measures for ten days and was then X-rayed. This disclosed a large ulcer on the lesser curvature. Following this he was given a course of duodenal feeding for a period of twenty-eight days. He improved very rapidly, as, during this period he gained eleven pounds in weight. On further X-ray examination no evidence of ulceration was found. He has remained in good health for the past twelve months.

The next case is one of particular interest.

Case 16. Mr. T.W. Aged 50.
This patient gave the following history on admission to hospital. He had always been a very healthy man until four years ago, when, while at work, he had received a severe blow from a spade in the epigastric region. He dated his gastric trouble from the time of this injury. This pain had gradually become worse over four years, until, on the 2nd October, 1927, he was suddenly seized with very severe abdominal pain and was admitted to hospital with a diagnosis of perforated gastric ulcer. He was operated on immediately and a large perforated ulcer was found at the cardiac end of the stomach. This was closed with a purse string suture but no improvement followed the operation, and he was unable to work. He was readmitted to hospital with a view to further surgical treatment and, on operating, a very large ulcer was found at the cardiac end of the stomach on the lesser curvature. This ulcer was considered to be too near the cardiac end of the stomach for the performance of a gastro-jejunostomy, and gastrectomy was not considered to be safe. He was transferred to my care for treatment with the duodenal tube. This was passed with the greatest of ease and he immediately experienced complete relief. Feeding was continued for a period of twenty-one days, during which time he gained four pounds in weight. He was then put on a light diet and, although he experienced no discomfort,

I felt that, having regard to the size of the ulcer as seen at the operation, a further period of duodenal feeding was desirable. Accordingly, the tube was passed again and a further course of feeding given for three weeks, making six weeks in all. He remained in hospital altogether for ten weeks and gained fourteen pounds in weight. X-ray examination prior to discharge did not show any evidence of ulceration but, owing to the situation of the ulcer, not much reliance was placed on this. He was told to report frequently and remained in good health for twenty-one months when he suddenly developed symptoms of pyloric obstruction and was again admitted to hospital. X-ray examination showed an almost complete obstruction of the pylorus, and it was decided to operate again without delay. At this operation a band of adhesions was found binding down the pylorus and these adhesions were separated. A search was made for signs of the old ulcer, as I was particularly anxious to see this, but nothing was found beyond a small area of fibrous tissue at its former situation. He made a complete recovery.

I feel that this case is one of particular interest, firstly, on account of the fact that his ulcer appears to have been of traumatic origin; secondly, that duodenal feeding succeeded after surgical measures had failed; and, finally, that one had the interesting experience of actually seeing the results of duodenal feeding in the healed ulcer some twenty-one months after the course of treatment.

In all, I have treated some thirty cases of gastric ulcer by this method, and, with one exception, all have been successful. I have, however, only described the above sixteen cases, in which treatment was completed more than twelve months ago. One hopes that these patients have been permanently cured, and possibly they may seem to be, but I feel that the

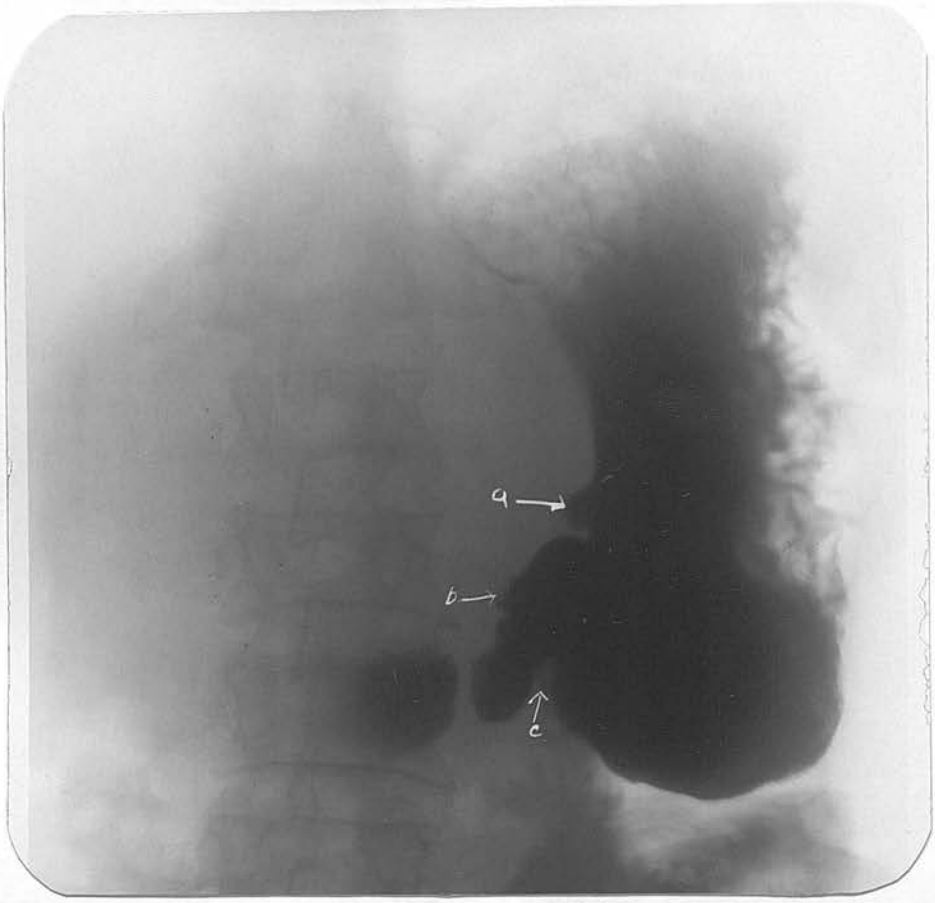
length of time which has elapsed is too short a period to justify my claiming a definite cure in a chronic condition such as gastric ulcer. I do, however, think that these results strongly indicate that this treatment is deserving of a fair trial in all cases in which the ulcer is situated on the lesser curvature of the stomach, all the more so when one remembers that the majority of these patients were drawn from a very poor district of London where home conditions and conditions for careful dieting are not too satisfactory.

On the following pages are shown a series of X-ray photographs, illustrating, in the first case a gastric ulcer before, during, and after treatment with the duodenal tube and, in the second case, a gastric ulcer before and after the same method of treatment.

X-ray photograph showing two ulcers, situated on the lesser curvature of the stomach, before treatment with the duodenal tube.

a- Ulcer niche. b- Ulcer niche.

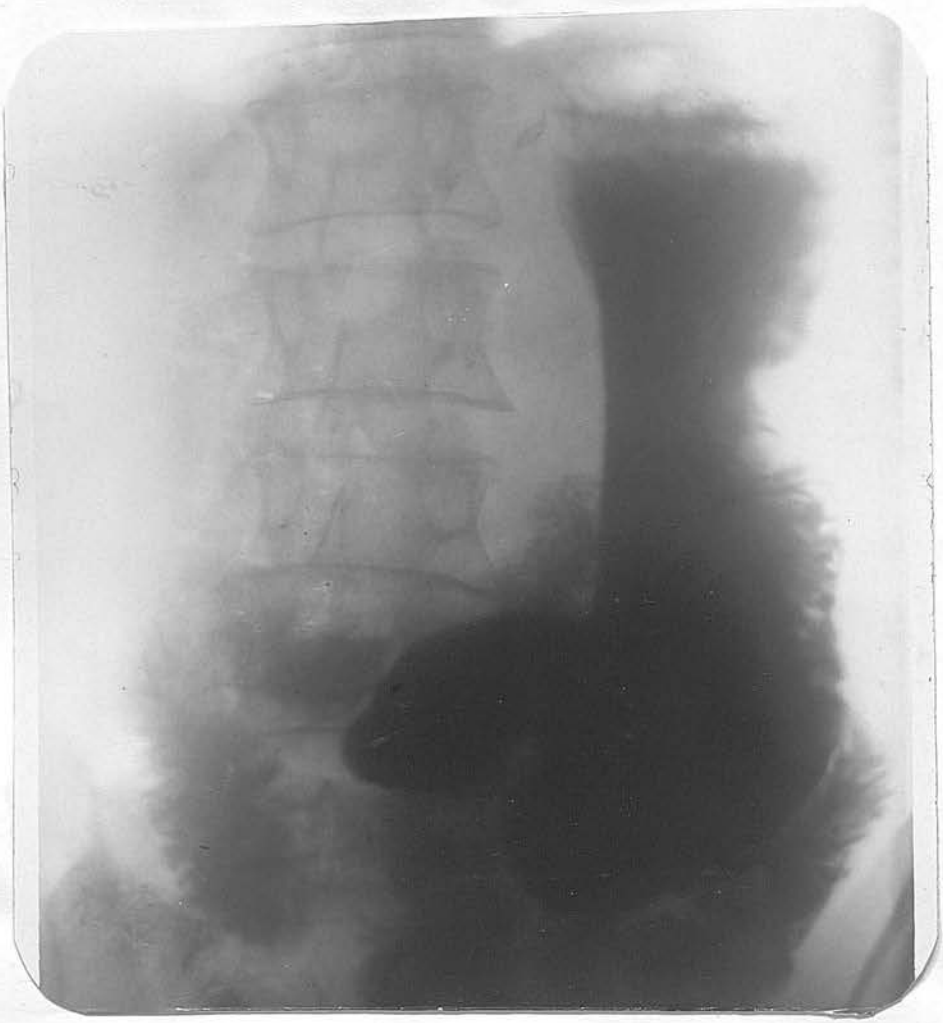
c- Prepyloric incisura.



The same case after fourteen days duodenal tube treatment. It will be observed that the ulcers have decreased considerably in size.

a- Ulcer niche. b- Ulcer niche.

c- Prepyloric incisura.



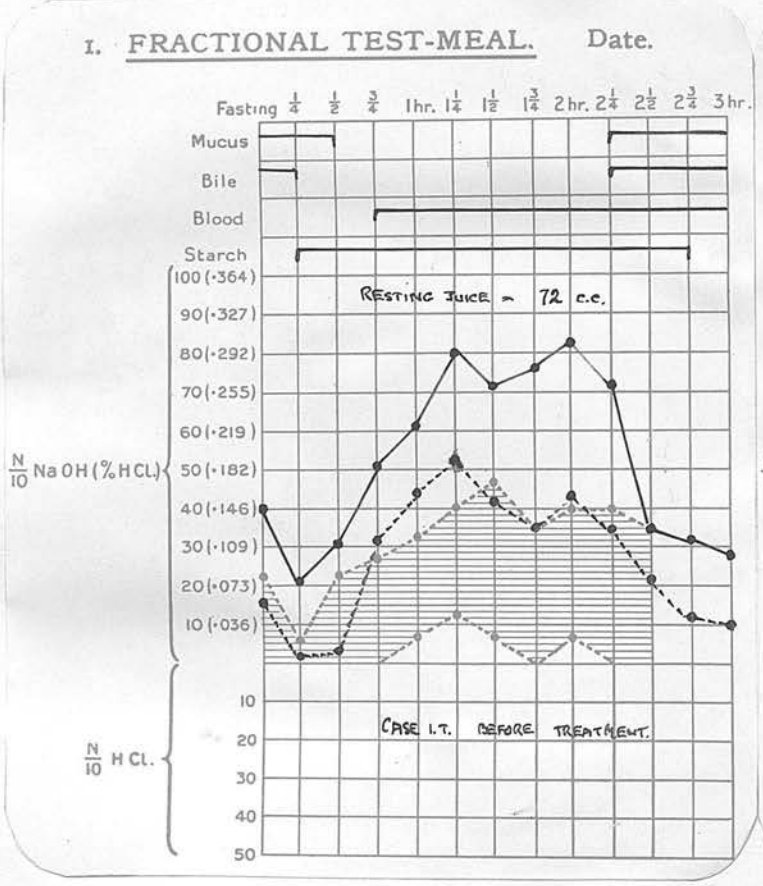
An X-ray photograph from the same patient after a course of duodenal feeding. There is no evidence of ulcer. The prepyloric incisura is still present, probably due to adhesions.

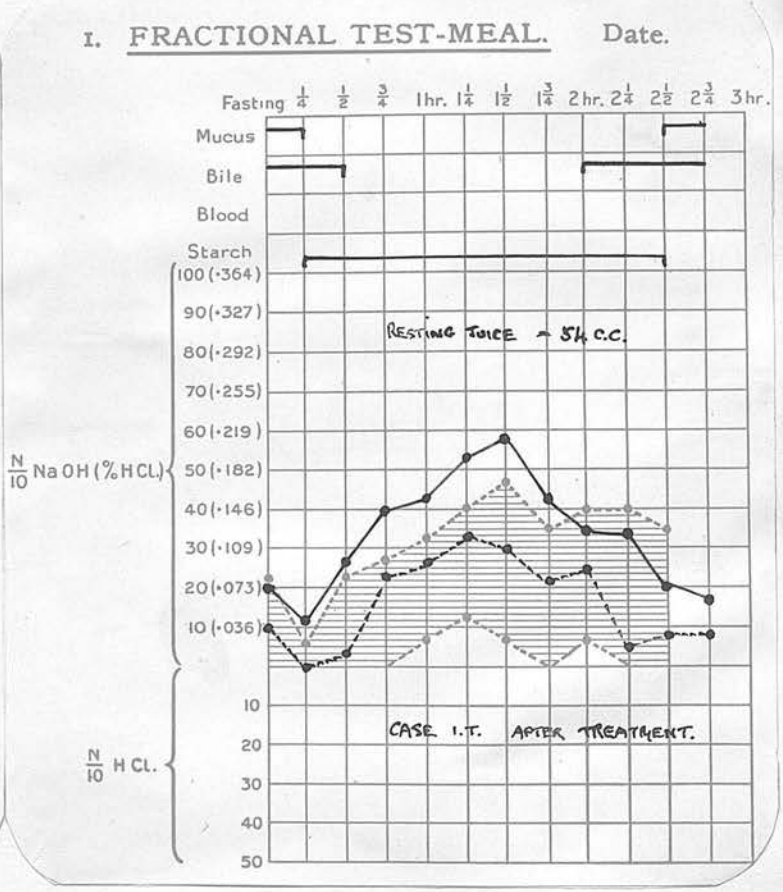
This X-ray photograph is from another patient and shows an ulcer (a) on the lesser curvature of the stomach before treatment with the duodenal tube.

An X-ray photograph from the same patient four weeks later. It will be observed that the ulcer niche has entirely disappeared.

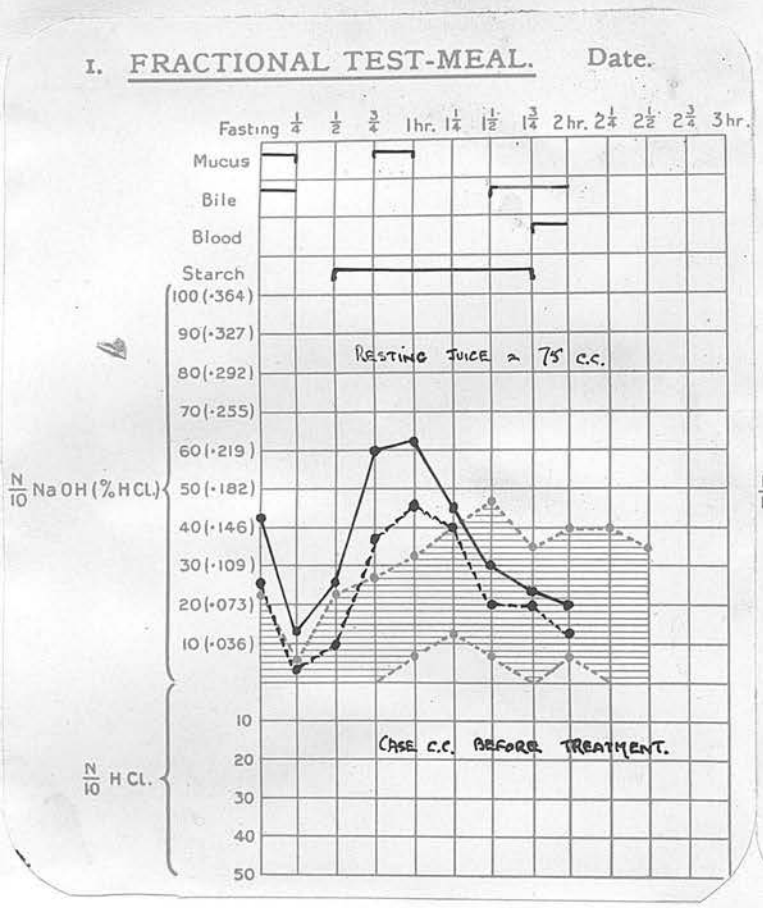
FRACTIONAL TEST-MEAL RESULTS IN CASES OF GASTRIC ULCER, BEFORE AND AFTER, TREATMENT WITH THE DUODENAL TUBE.

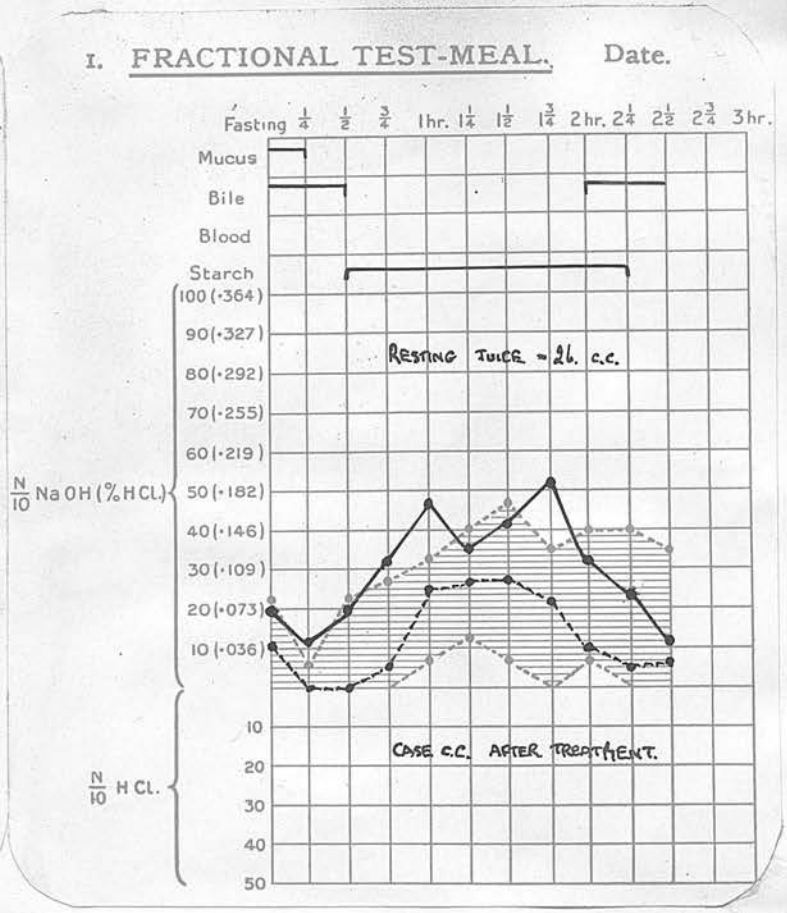
The following series of charts serve to illustrate the difference in the results obtained from fractional test-meal examinations previous to and after treatment with the duodenal tube. In each case the two charts have been placed side by side for comparison.



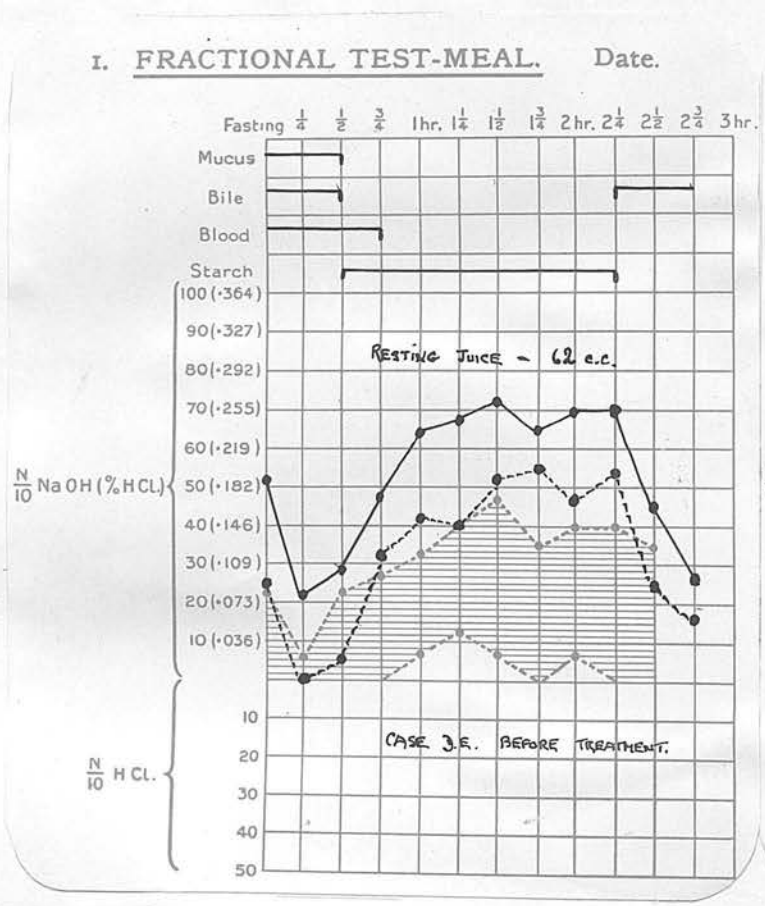


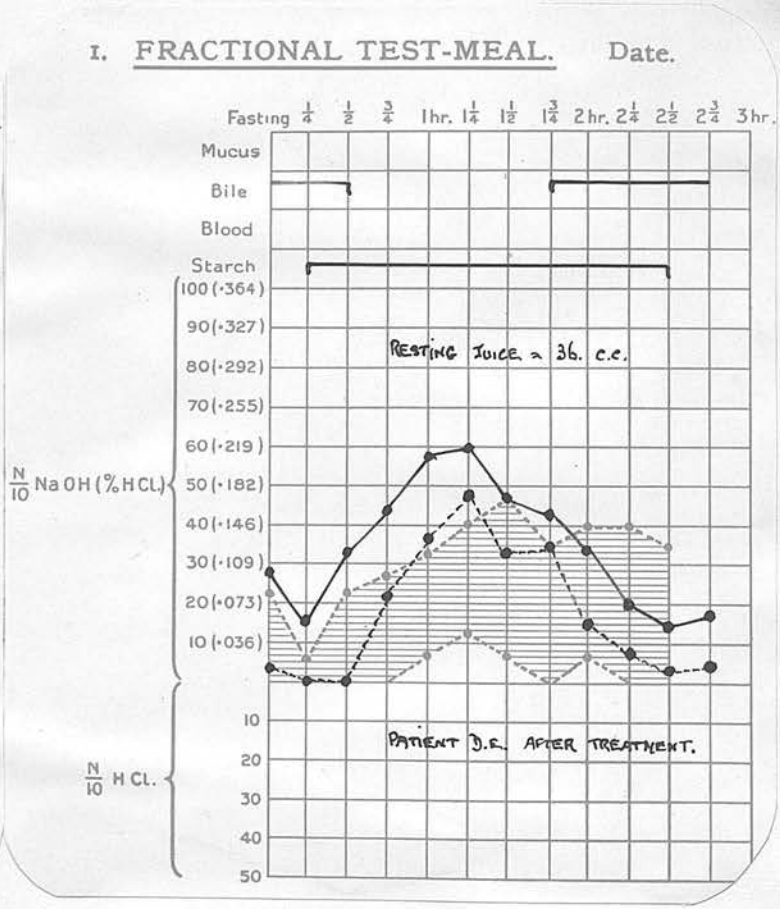
In this case the patient was considered to be too ill for X-ray examination. The fractional test-meal, however, shows the characteristic plateau associated with ulcer on the lesser curvature of the stomach. After treatment, both total and free acidity curves had fallen considerably and, the plateau effect was no longer in evidence. The volume of resting juice was 72 c.c. before treatment compared with 54 c.c. afterwards.



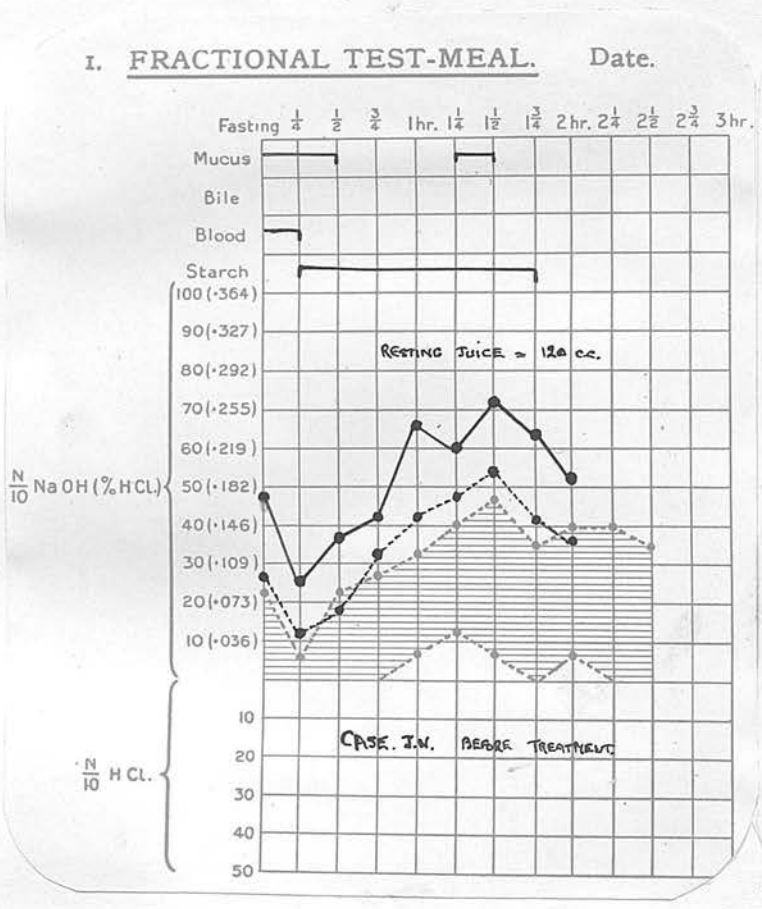


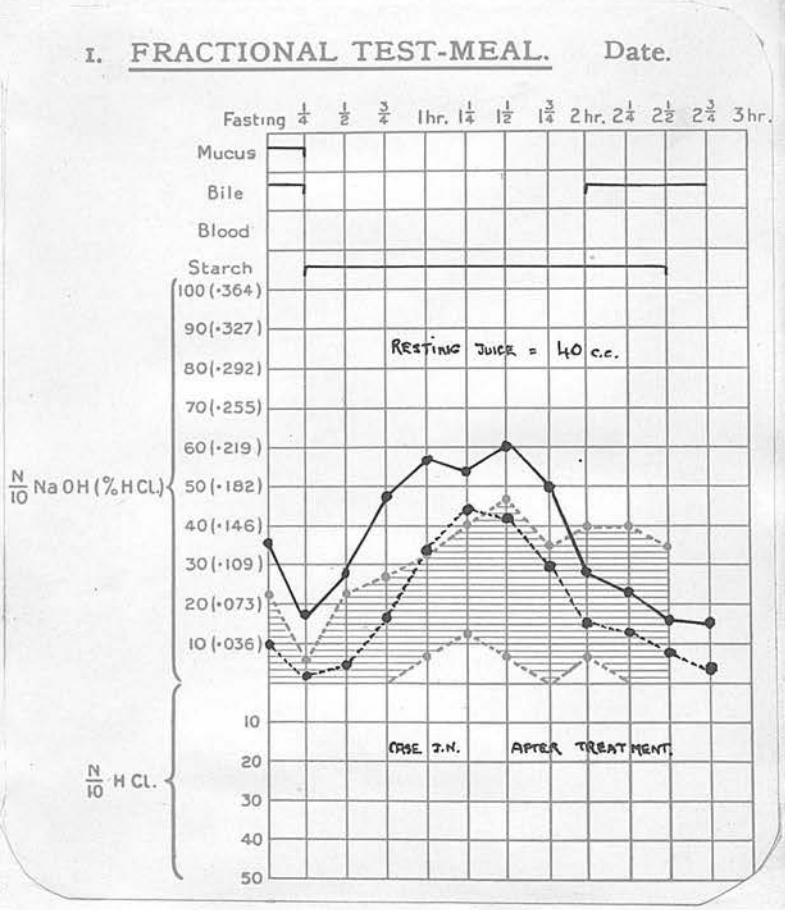
In this case X-ray examination showed an ulcer to be present on the greater curvature of the stomach. The chart, before treatment, does not appear to me to be at all typical of gastric ulcer, but shows the total acidity rising rapidly to a peak and then dropping at an equally rapid rate. The stomach was completely empty in two hours. It is possible that the blood, present at the end of the first meal, was traumatic. After treatment the curve presents a more normal appearance. The volume of resting juice, after treatment, was 26 c.c. as compared with 75 c.c. before.



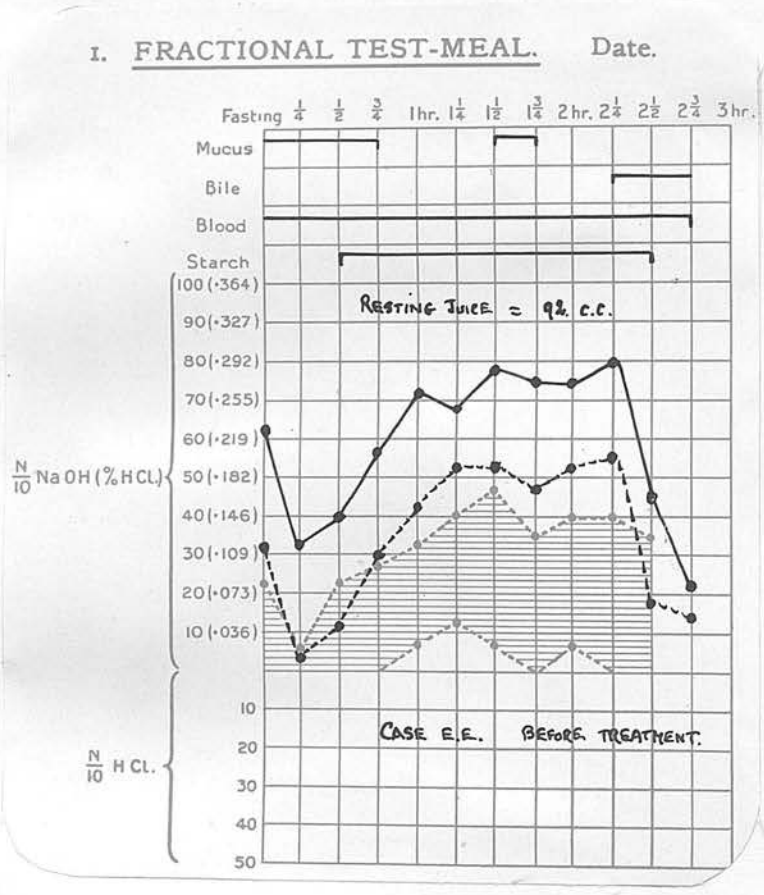


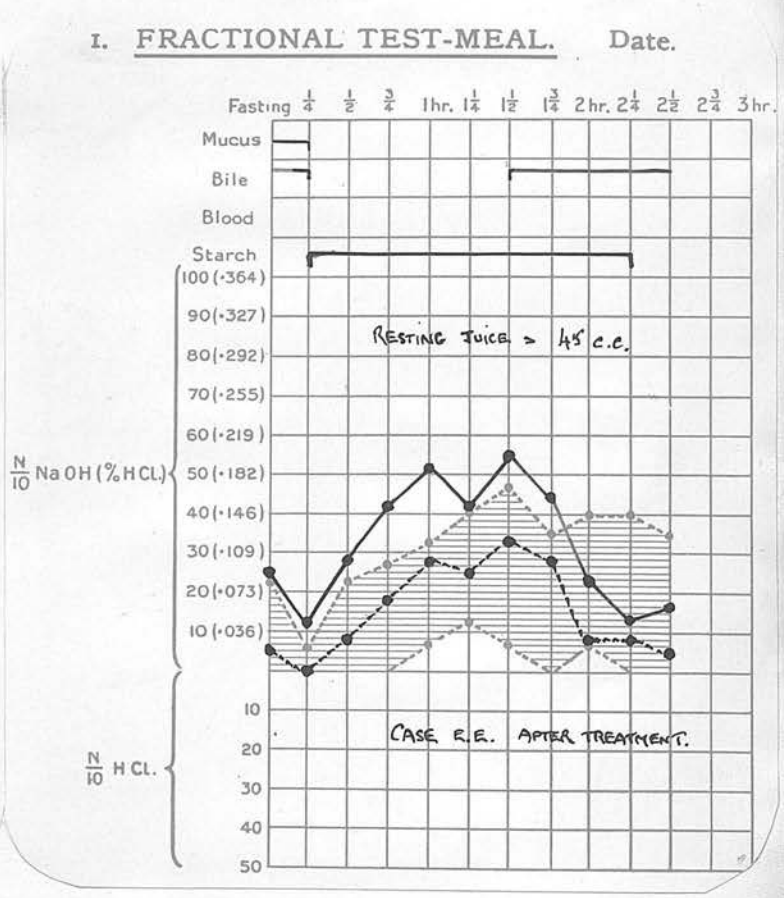
This case was considered too ill for X-ray examination. The fractional test-meal again shows the plateau effect commonly found in cases of ulcer situated on the lesser curvature of the stomach. Blood was present in the early specimens. After treatment the plateau effect is absent and, there is an increased regurgitation of bile. The volumes of resting juice before and after treatment were 62 c.c. and 36 c.c. respectively.





A case of gastric ulcer where X-ray examination showed the ulcer to be situated close to the pylorus. Before treatment there was no regurgitation of bile either before the fractional test-meal or at its close. The curve would appear to indicate spasm of the pylorus. After treatment bile was present in moderate amount, and the curves of both total and free acidity had dropped slightly - the whole indicating a more normal gastric response and the absence of pyloric spasm. The volume of resting juice was 120 c.c. (containing blood) before treatment, while after treatment its volume had decreased to 40 c.c.





X-ray examination of this patient showed an ulcer to be present close to the pylorus and situated on the lesser curvature. The fractional test-meal shows a very marked plateau-effect throughout, and blood was present in every specimen. After treatment the curves had dropped very considerably. The volume of resting juice before treatment amounted to 92 c.c. as compared with 45 c.c. after treatment.

THE TREATMENT OF DUODENAL ULCER AND CERTAIN CASES OF JUXTA-PYLORIC ULCER BY MEANS OF THE DUODENAL TUBE.

It might be thought that, having obtained such satisfactory results in the treatment of gastric ulcer, those relating to duodenal ulcer or juxta-pyloric ulcer when situated on the duodenal side of the pylorus would be equally good but, in practice, I have found that this is not the case.

I have attempted this line of treatment in many such cases but have had only one successful result, and I have now abandoned the procedure. It was found that patients experienced no relief from their symptoms and, I feel sure that, in one or two cases, these were aggravated.

I think the reason for this failure is probably due to the tube itself rather than to the instillation of food, for, it is possible, by passing a greater length of tubing, to ensure that the nozzle has passed beyond the duodenum. On the other hand, the tube in these cases, is lying in a very confined space, and, as it is constantly moving to and fro I feel that it is bound to come, very frequently, into actual contact with the surface of the ulcer thus causing irritation and preventing healing.

LAVAGE OF THE SMALL INTESTINE.

It has been my practice, in all cases treated with the duodenal tube, to carry out daily irrigations through the tube itself. As the first thing in the morning and the last thing at night a solution, either of normal saline or of potassium permanganate, is passed down the tube.

I believe that this procedure is of very marked benefit to the patient in that it flushes out the small intestine and, when one considers that this is a large absorptive area of the body, the importance of rendering it clean and wholesome is enormous.

I consider the potassium permanganate solution to be more efficacious than the normal saline and, treatment should be commenced with a strength of half-a-grain to one pint of water. This may be continued for one week and then gradually increased to one grain to the pint of water. Not more than one pint of fluid should be passed into the duodenum at a time.

LAVAGE OF THE SMALL INTESTINE WITH SOLUTIONS OF POTASSIUM PERMANGANATE.

In cases treated by this means for any length of time, such as those of gastric ulcer, I have noticed that the blood-pressure was invariably lower at the end of treatment than at the commencement. At first, I was inclined to attribute this to the light dieting and, to the general establishment of healthier conditions but, later, I began to consider whether this might not be due to the action of the potassium permanganate itself. I now believe this to be the case as, in a series of cases where lavage was omitted and only duodenal feeding employed, I did not obtain any decrease in the blood-pressure readings.

I then thought that this reduction in blood-pressure might possibly be procured by the introduction of potassium permanganate by other channels, and I commenced a series of experiments in which similar doses of the permanganate were introduced in the form of ten-ounce retention-enemata. Absorption into the portal system takes place in these cases through the superior hemorrhoidal vein. In every instance blood-pressure readings were found to be reduced after this treatment had been continued for at least fourteen days although not to the same degree as in duodenal lavage.

Again, in a further series of patients who suffered from high blood-pressure and were treated by lavage through the duodenal tube, but without duodenal feeding, it was found that a considerable decrease in the blood-pressure took place.

These results lead one to infer that a definite fall in blood-pressure follows the continuous medication with potassium permanganate.

It is probable that little of the potassium permanganate, when introduced into the upper bowel, is absorbed unchanged and I believe that the chemical changes may be represented by the following equation:-

$$2\ KMnO_4 + 16\ HCl = 2KCl + 2\ MnCl_2 + 5\ Cl_2 + 8\ H_2O$$

The possibility of such chemical action was confirmed by experimental work, in the laboratory, on duodenal contents and, varying strengths of hydrochloric acid, to which were added solutions of N/10 potassium permanganate. It was found that free chlorine was evolved and solutions of potassium chloride and magnesium chloride resulted.

The evolution of chlorine is of particular interest in view of its antiseptic properties and, it may well be that it contributes in no small way to the benefit derived from duodenal lavage with solutions of potassium permanganate.

The following tables illustrate the blood-pressure readings, in each case over a period of three weeks, in groups of patients; (1) those with more or less normal blood-pressures who were undergoing a course of duodenal feeding and duodenal lavage; (2) those with high blood-pressure readings who were treated with duodenal lavage but no duodenal feeding. The readings in each case were taken three times on one day with one week's interval between, so that every figure recorded in the tables is the average of three readings.

Blood-pressure readings taken during a course of duodenal feeding and small intestine lavage with solutions of potassium permanganate.

	Before treatment	1st week	2nd week	3rd week	Total drop in systolic reading.	Difference in pulse pressure.
Case 1 (45)	138/82	130/82	126/82	114/78	12	- 8
Case 2 (38)	120/80	112/78	112/80	110/80	10	- 10
Case 3 (31)	146/92	138/82	122/74	118/72	28	- 8
Case 4 (24)	120/70	116/72	110/70	110/70	10	- 10
Case 5 (52)	154/86	138/84	128/76	128/74	26	- 14
Case 6 (61)	158/88	146/84	140/80	136/76	22	- 8
Case 7 (20)	120/76	120/78	100/64	92/54	28	- 6
Case 8 (29)	128/78	124/76	124/76	120/72	8	- 2
Case 9 (26)	118/66	126/70	112/70	110/72	8	- 14
Case 10 (50)	148/86	142/86	134/78	130/72	18	- 4
Case 11 (33)	136/86	134/86	126/82	126/82	10	- 6
Case 12 (29)	138/80	138/78	130/78	128/80	10	- 10
Case 13 (47)	150/86	145/84	142/84	142/84	8	- 6
Case 14 (23)	127/76	124/74	124/74	122/74	5	- 3
Case 15 (48)	145/86	140/82	134/82	134/82	11	- 7
Case 16 (32)	132/78	128/78	125/74	120/74	12	- 8

Blood-pressure readings, in subjects with high blood-pressures, during a course of small intestine lavage with solutions of potassium permanganate.

	Before treatment	1st week	2nd week	3rd week	Total drop in systolic reading.	Difference in pulse pressure.
Case 1 (64)	214/118	212/114	198/114	194/112	20	- 14
Case 2 (68)	198/104	195/104	185/102	184/102	14	- 12
Case 3 (71)	224/112	218/110	208/108	208/106	16	- 10
Case 4 (60)	188/102	184/102	180/102	175/100	13	- 11
Case 5 (63)	195/102	195/100	188/98	182/98	13	- 9
Case 6 (74)	204/115	198/112	192/112	185/110	19	- 14
Case 7 (72)	196/100	192/100	185/95	180/100	16	- 16
Case 8 (57)	182/96	178/94	176/94	168/88	14	- 6
Case 9 (61)	215/114	214/112	206/108	194/108	21	- 15
Case 10 (66)	242/128	238/126	230/124	225/124	17	- 13

These cases were observed for a further three months, and at the end of this period it was found that while in every case the blood-pressure had risen slightly in none did it equal the original reading.

THE DUODENAL TUBE IN NORMAL AND ABNORMAL CONDITIONS OF THE GALL-BLADDER.

By means of the duodenal tube it is possible to secure specimens of bile as it enters the duodenum from the common bile duct, and obtain therefrom valuable information concerning the state of the gall-bladder.

The tube is passed in a manner similar to that described under the treatment of gastric ulcer but, after the tube has entered the duodenum, the patient is kept on the right side and the duodenal contents are either aspirated or allowed to syphon off over the edge of the bed into a suitable receptacle.

The photograph below illustrates the method in progress.

In the "Journal of the American Medical Association", Vol. 85, No. 20, 1541, Lyon and Swalm describe three vicious circles in connection with disease of the gall-bladder, liver, and pancreas.

The first is of the nature of a lymph-connection between the liver, gall-bladder, and pancreas, and this circle is only broken by the removal of the gall-bladder itself.

The second vicious circle consists of the absorption of bacteria etc. through the intestinal walls into the mesenteric veins and, part may be diverted by means of the hepatic veins into the inferior vena cava.

The third circle described by these writers is one in which the toxic products are absorbed by the mesenteric lacteals, carried to the receptaculum chyli, and thence, via the thoracic duct and the sub-clavian vein into the systemic system.

It is in the second, and particularly the third type of vicious circle that duodenal drainage and lavage is of value in that each treatment removes from the body many millions of bacteria and many septic products which would otherwise be absorbed. It thus exercises a cleansing action on the duodenum and the small intestine which cannot fail to be of benefit.

According to Lyon and Swalm this treatment

"drains the liver; revitalises its cells; flushes the ducts; prevents clogging with mucus, inflammatory products, or infected debris; minimises the possibility of formation of secondary calculi; drains the pancreas and lightens its labours; and lessens chemical and bacterial insults to the intestinal mucosa".

The drainage of bile may be carried out by two methods, viz., continuous or intermittent.

The following method is recommended by Lyon and Swalm for continuous drainage:-

8 a.m. The mouth and throat are prepared by gargling.

8.30 a.m. to noon. The tube is passed and, after stimulating either with magnesium sulphate solution, peptone, olive oil, normal saline, or hot water, duodenal drainage is carried.

12 noon. The following duodenal feed is given:-

Milk.	120 c.c.	80 calories.
Cream.	15 c.c.	30 "
Yolk of one egg.		50 "
Lactose.	15 gm.	60 "
Salt.	One pinch.	
		220 calories.

The food is predigested for ten minutes with a peptonising powder, and introduced slowly by the drip method, no less than thirty minutes being taken for its introduction.

1 p.m. to 4 p.m. Duodenal drainage is continued.

4-5 p.m. Duodenal feeding is repeated.

5-8 p.m. Bile drainage is repeated.

8-9 p.m. Duodenal feeding.

9 p.m. The bile is allowed to drain into a gallon bottle during the night until eight the next morning.

the tube is now retained in position and the above procedure carried out daily.

I have tried this method in several cases but have invariably found it far too drastic. The patients complain of great weakness after a few days, and I further consider that too much bile and other duodenal contents, such as pancreatic secretion, are removed. I feel that in biliary drainage, especially after the flow of bile has been stimulated, the main flow is obtained in the first four hours, and that any further removal of the duodenal contents is too drastic and may be harmful. This contention is supported by figures relating to the flow of bile which are shown on page 59.

In the cases which I have treated, I have modified this method considerably and, only carry out drainage once a day from 8 a.m. to noon. This is immediately preceded and followed by lavage of the duodenum and small intestine. During the remainder of the day, the patient is fed by the mouth on a diet suitable to his case. This allows full benefit to be derived from the action of the gastric juices. The duodenal tube is left in position during the whole period of treatment, which generally lasts from two to three weeks. The tube causes no inconvenience when ordinary food is being swallowed as it is easily

retained in one of the angles of the mouth and anchored over the ear by means of a loop of tape.

This method may be summarised as follows:-

7.30 a.m.	Duodenal lavage with twenty ounces of normal saline solution.
8 a.m. to noon.	Duodenal drainage after stimulation with two ounces of a twenty-five per cent. solution of magnesium sulphate.
12 noon.	Duodenal lavage with potassium permanganate solution. This is commenced with a strength of half-a-grain to the pint and increased every four days by a further half-grain until a maximum of two grains to the pint is reached.
12.45 p.m.	A good meal selected to suit the requirements of the case.
2 p.m.	One glass of citrated milk.
4 p.m.	Tea and toast.
6.30 p.m.	A meal as at 12.45 p.m.
9.30 p.m.	One glass of citrated milk with biscuits.

I felt, at the commencement of this study, that it was essential to have some definite information regarding the average secretion of bile in the healthy individual and, in a series of twenty cases, one half males, the other half females, between the ages of twenty-five and thirty-five, I found that the average amount of bile recovered during a four-hours' drainage was two-hundred-and-sixty-nine c.c. (269 c.c.).

The tables which follow show how remarkably uniform were the results in each case, the males appearing to secrete about five c.c. more per hour than the females.

MALES.

	Age.	1st. hour.	2nd. hour.	3rd. hour.	4th. hour.	Total obtained in four hours.
Case	1 (26)	82	76	58	50	266 c.c.
Case	2 (28)	90	74	56	52	272 "
Case	3 (32)	96	80	58	54	288 "
Case	4 (29)	84	82	62	58	286 "
Case	5 (26)	70	72	68	62	272 "
Case	6 (33)	92	84	64	59	299 "
Case	7 (31)	93	86	56	50	275 "
Case	8 (27)	84	78	56	52	270 "
Case	9 (29)	78	76	54	50	258 "
Case	10 (35)	94	86	60	54	294 "

FEMALES.

Case	1 (27)	89	82	52	50	273 "
Case	2 (31)	72	70	48	44	234 "
Case	3 (29)	79	71	51	37	238 "
Case	4 (34)	88	79	58	46	271 "
Case	5 (29)	80	73	52	48	253 "
Case	6 (30)	65	63	47	46	221 "
Case	7 (25)	79	74	53	45	251 "
Case	8 (34)	91	75	49	43	258 "
Case	9 (26)	85	69	51	47	252 "
Case	10 (34)	78	72	52	45	247 "

Average amount recovered from healthy males:-

278 c.c. in four hours.

Average amount recovered from healthy females:-

249.8 c.c. in four hours.

It will be noticed that in every case the maximum secretion took place during the first and second hours, and was followed by a comparatively big drop at the third hour, and a still further decline in the fourth hour although to a lesser degree. I anticipate that the reason for the higher results obtained during the first two hours is that these include bile already lying in the bile ducts and in the gall-bladder.

These figures must include some pancreatic as well as biliary secretion, and it is further probable that more is actually secreted than these tables indicate, for it is too much to expect that all the secretion is recovered.

In the next place I attempted to ascertain, in the same series of cases, the response of biliary secretion to the application of various stimuli. The stimulants used were:-

(1) Two ounces of a 25 per cent. solution of magnesium sulphate.
(2) Two ounces of a 25 per cent. solution of sodium bicarbonate.
(3) Two ounces of a 25 per cent. solution of sodium sulphate.

(4) Two ounces of a 10 per cent. solution of sodium phosphate.
(5) Two ounces of a 10 per cent. solution of hydrochloric acid.
(6) Two ounces of a 10 per cent. solution of nitro-hydrochloric acid.

All of the above were introduced directly through the tube, and the average of ten cases comprising five males and five females is given in the table which follows. By way of comparison I have placed at the top of this table the figures from a case which corresponds as closely as possible with what I have found to be the normal.

	1st. hour.	2nd. hour.	3rd. hour.	4th. hour.	Total in four hours.
Normal.	82	76	58	50	266 c.c.
Magnesium sulphate.	224	102	52	41	419 "
Hydrochloric acid.	180	94	48	53	375 "
Nitro-hydrochloric acid.	177	85	52	50	364 "
Sodium phosphate.	163	80	54	49	346 "
Sodium sulphate.	142	78	56	52	328 "
Sodium bicarbonate.	150	73	53	51	327 "

In all the above cases the drainage was carried out between the hours of 8 a.m. and noon.

In these results it is interesting to note that the twenty-five per cent. solution of magnesium sulphate produces an increase in secretion far in excess of any of the other stimulants; that in every instance the increase of secretion takes place practically within the first hour; that with every stimulant, secretion has returned to normal in the third hour; and, that in the fourth hour the secretion following stimulation with magnesium sulphate, despite its high total, is markedly less than any of the others.

VARIOUS TYPES OF BILE.

A very considerable amount of literature has been written concerning the various types of bile secreted, and there appears to be much divergence of opinion regarding this. Most workers appear to have made their observations after the flow of bile had been stimulated by some outside agent. In view of the tables shown above I feel that such methods cannot give accurate results. If one takes the case of magnesium sulphate alone, it will be seen that, after stimulation with this drug, the secretion of bile in one hour's time amounts to no less than eighty-four per cent. of the total bile secreted in four hours

under normal circumstances. I have preferred to base my observations on the flow of bile under normal conditions.

It is generally realised that there are three types of bile and these have been termed:-

(1) "A", or duct bile.

(2) "B", or vesicular bile.

(3) "C", or bile coming direct from the liver.

Vesicular bile is supposed to be darker in colour than bile from the ducts, while liver bile is clear and yellow. I must confess that I have never been able to distinguish between the so-called "A" and "B" types of bile. If one considers that the capacity of the common bile-duct cannot be much more than ten c.c. it would appear to me that so small a quantity when mixed with the other duodenal secretions can no longer be recognised outside the body by its true appearance.

I believe, however, that "B" or gall-bladder bile becomes darker in appearance as drainage continues, and appears to reach a maximum in about two hours' time, while its density increases at a corresponding rate.

The following table shows the specific gravity of bile taken every half-an-hour during drainage with the duodenal tube under normal conditions.

The figures represent the average of twenty cases.

Specific gravity of bile, during drainage with the duodenal tube, at intervals of :-

½hr.	1hr.	1½hrs.	2hrs.	2½hrs.	3hrs.	3½hrs.	4hrs.
1.0318.	1.020.	1.0213.	1.0232.	1.0226.	1.0214.	1.0172.	1.0166.

(Standard taken as 1).

This would appear to indicate, and support the theory, that the essential function of the gall-bladder is to concentrate bile.

I have found that on the average this dark bile generally continues up to the end of the first two hours' drainage, when it gradually becomes lighter, till in the majority of cases a golden-yellow is reached. This is, however, not always the case, for I have seen what was undoubtedly liver-bile, from an apparently healthy person, which was dark-brown, like treacle, in colour but much more fluid in consistence. I feel that, in the majority of cases, if this golden bile does not appear by the end of two hours' time, there is reason to suspect that some pathological condition is present.

THE EXAMINATION OF DUODENAL SECRETIONS.

An examination of gall-bladder bile frequently yields important information regarding the condition of that organ and may be a valuable aid in confirming the diagnosis of gall-bladder disease although, I believe, that positive results only are of any diagnostic value.

Firstly the amount of bile secreted should be noted, for I believe that in all conditions of a pathological nature relating to the liver or gall-bladder, the flow of bile is diminished. In no case associated with definite disease of either of these organs have I obtained more than fifty c.c. in the first hour of drainage instead of the normal of approximately eighty c.c. I believe that any decrease in secretion below thirty c.c. indicates a definite pathological lesion.

In experiments with ten cases of catarrhal jaundice, which should probably be more correctly termed mild hepatitis, I found that the average amounts of duodenal secretion recovered were:-

	1st. hour.	2nd. hour.	3rd. hour.	4th. hour.	Total.
Normal.	82	76	58	50	266 c.c.
In catarrhal jaundice.	41	25	17	14	97 c.c.

A total difference of 169 c.c.

Again, failure to procure any bile would indicate the presence of some obstruction, and I have observed this in cases of obstruction of the common bile duct by gallstones, or by pressure of new growths from without.

The amount of mucus present is important as indicating some degree of inflammation. In this connection I can recall one case of duodenal drainage where after two days, during which only a few c.c. of bile were recovered, the tube became blocked. The tube was withdrawn for examination and found to be choked with very dense mucus, while, hanging from the nozzle, was a foul-smelling plug of mucus about three inches long twisted like a piece of string. On the tube being re-introduced into the duodenum it was found that bile began to flow quite freely, and I feel certain that this mucus was virtually a cast of the common bile duct which it had completely blocked so causing the jaundice from which the patient suffered.

Under normal conditions very few formed elements are to be found in bile, and in a large number of examinations I have only been able to detect a few epithelial cells and an occasional leucocyte. In appearance it should be clear but not transparent, and on standing, should show only a slight deposit of mucus.

In pathological conditions, however, the important points to be noted are an increase in the number of leucocytes, the presence of red blood corpuscles, the presence of degenerated epithelia which are nearly always bile stained, and marked epithelial exfoliation. The presence of cholesterol crystals, and less frequently, fatty acid crystals, indicate, in some degree, diseased conditions, while in the more severe inflammations pus-cells are frequently found. The number of bile-stained polymorphonuclear leucocytes is an indication of the degree of inflammation. It is important to distinguish between the types of epithelial cells present in the microscopic film. Tall columnar gall-bladder epithelium calls for no comment, but the short columnar epithelium derived from either the gall-bladder or the bile-ducts, more commonly the latter, must be differentiated from the transitional epithelium of the pyloric region or the epithelium of the duodenum. In these the cells are ovoidal or cuboidal, never columnar.

Bile culture does not provide reliable information as to the presence, or absence, of gall-bladder infection. This was definitely proved by the careful investigations of Wilkie, who showed that a virulent infection in the walls of the gall-bladder could be associated with sterile bile.

THE BACTERIOLOGY OF THE DUODENUM.

In dealing with the bacteriology of the duodenum, both in health and disease, it should be remembered that the stomach must be looked upon as a barrier to infection. It is now generally agreed that bacteriological findings relating to the stomach contents are influenced by the degree of acidity and, more especially, by the amount of free hydrochloric acid present. It therefore follows that the duodenum, in view of its close relation to the stomach, must be considerably affected by the conditions prevailing in that organ.

Further, results from cultures can be of no significance unless special precautions are taken against contamination. In connection with this point I have been successful in introducing a tube into the duodenum in such a manner that, at least, the inside of the tube will be sterile, and the technique of this will be described later.

The following is an abbreviated extract relating to this subject from W.W. Ford's Textbook of Bacteriology:-

> "Stomach. Smears from contents in full digestion show great numbers of bacteria and great variety. Many represent bacteria from the mouth, while others are due to food contamination.
>
> "After gastric digestion very few are left, due to the high acidity, and rapid elimination with the food into the duodenum.

"Small Intestine. As shown by Cushing and Livingwood the contents of the duodenum, jejunum, and ileum are practically sterile. In many instances, however, small gram-negative bacteria, either bacillus coli or bacillus lactis aerogenes, are found implanted on the mucosa.

"Pathogenic Organisms. Many of the ordinary intestinal bacteria such as bacillus coli and bacillus lactis aerogenes are occasionally virulent to small animals but, in general, disease-producing bacteria do not occur normally in the intestinal tract. Rarely pyogenic cocci may be found in the stomach, but these are generally destroyed by the gastric juice. On occasion, virulent streptococci are found but, in general, the streptococci found under normal conditions are non-pyogenic. Especial interest attaches to the anaerobes which may be present in spore or vegetative forms, thus, bacillus Welchii is almost always found but appears to have no pathological significance".

The above conveys the impression that the gastric juices are definitely bactericidal in their action, and the question might be raised as to whether this is actually the case, or whether the gastric juice merely inhibits the growth of bacteria.

I have found that, in many instances, growths of bacteria were obtained from various dilutions of the gastric contents when direct platings of the same specimens gave negative results. This suggests that the growth of bacteria was inhibited by the presence of gastric secretion on the surface of the medium and, it is possible, that a similar inhibitory action takes place in the stomach.

Against this, after very many observations concerning the bacteriological findings in the duodenum, I have been impressed with the absence of bacteria, in cultures of various dilutions, from the healthy subject. If one considers the enormous numbers of bacteria swallowed into the stomach and which never reach the duodenum, it seems definite that the gastric juices have a very potent bactericidal action.

Further, to quote Izod Bennett in "The Stomach and Upper Alimentary Canal in Health and Disease" :-

> "The alimentary canal, throughout its whole extent, is the home of bacteria of bewildering variety. At the same time it is true that organisms of known pathogenicity are of relatively rare occurance. On the other hand, the pathogenic organisms which are swallowed in food, saliva, and sputum are innumerable, whereas the ill effects caused by them are relatively few in number and rare in incidence. This is probably due to the bactericidal action of the hydrochloric acid in the gastric juice, and it may be fairly claimed that one of the really important functions of the stomach is to provide a filter against the penetration of dangerous bacteria into the lower portions of the bowel. A vigorous culture of such organisms, typhoid-infected milk for example, may partially escape the filter, but, in many cases the gastric juice is able to destroy such invaders, and probably lowers the vitality and prevents multiplication of the bacteria in every case. So powerful is the gastric juice as a disinfectant that the most acute oral sepsis usually fails to establish infection of the alimentary canal as a whole".

Finally, we have a very conclusive proof of the bactericidal action of the gastric juices if we

consider one of the etiological factors in cholera. Most people who have resided in India or the Tropics appreciate the fact that the cholera vibrio is killed by acid, and realize that, in an epidemic, it is very frequently the person afraid of contracting the disease who, through his fear, inhibits the secretion of his gastric juices and so takes cholera. As a prophylactic measure it is usual to augment the gastric acidity by drinking lime-juice several times a day.

These observations are of interest in view of the bacteriological findings, from the duodenum in health and disease, shown in the table below :-

BACTERIOLOGY OF THE DUODENUM.

Disease.	Number of examin--ations.	Sterile.	Coliform bacillus.	Staphylococci.	Streptococci. (non-haemolytic)	Diplococcus pneumoniae.	Bacillus pyocyaneus.	Bacillus acidophilus.
Normal.	40.	32.	6.	4.	-	-	I.	5.
Duodenal ulcer.	I5.	-	I2.	6.	2.	I.	3.	5.
Chronic Cholecystitis and Cholangitis.	25.	4.	I9.	II.	6.	5.	7.	3.
Gall-stones.	I5.	3.	9.	6.	I.	-	-	2.
Gastric ulcer.	40.	I7.	I2.	7.	-	-	4.	II.
Gastric carcinoma.	I5.	-	I2.	7.	3.	I.	-	I.

Note;- The Oppler-Boas bacillus was found in 8 of the gastric carcinoma cases.

This table illustrates the somewhat striking difference existing in the bacteriological findings from the duodenum when the results relating to healthy persons are contrasted with those from cases of disease, either in the duodenum or organs adjacent to it.

It will be noted that while out of forty examinations of the duodenal contents from apparently healthy persons thirty-two (or eighty per cent.) were sterile, out of one-hundred-and-ten examinations where diseased conditions were present only in twenty-four (or twenty-two per cent.) was a sterile result obtained.

Further, the contrast becomes still more marked if the gastric cases are eliminated from the series for the sterile results then fall as low as four in fifty-five examinations.

It is not surprising that heavy growths are recovered from cases of gastric ulcer and carcinoma where the stomach presents broken surfaces most suitable for the implantation of bacteria. I have yet to see a case of duodenal ulcer where a sterile result from the duodenal contents was obtained.

The marked preponderance of coliform bacilli is perhaps noteworthy, it being found in seventy-five per cent. of the cases associated with disease.

Only a very small proportion of examinations showed a streptococcus, while the haemolytic streptococcus was found not at all.

The presence of the diplococcus pneumoniae in cases of chronic cholecystitis and cholangitis suggests, in view of the virulence of acute cholecystitis when associated with that organism, the possibility of acute exacerbations.

The whole indicates that in diseased conditions there is always a mixed infection present in the duodenum.

THE INTRODUCTION OF A STERILE TUBE INTO THE DUODENUM.

In endeavouring to secure these results the chief difficulty encountered was that of introducing a sterile tube into the duodenum in such a manner that, at least, the inside of such a tube would be sterile.

I found it possible to overcome this difficulty in the following manner:- First of all, the tube was boiled and one end sealed with a sterile clamp or pair of artery forceps. Next, the nozzle of the tube was plugged with sterile paraffin wax the melting-point of which was that of body temperature. Once the nozzle was safely in the duodenum, it was found possible, with the aid of a serum syringe, to blow out from the nozzle any wax remaining therein.

This method proved successful so long as the nozzle entered the duodenum rapidly, and before the wax had had time to melt. As this was not always readily achieved, especially in the cases of duodenal ulcer associated with pyloric spasm, the introduction of the tube had to be repeated over and over again before success was attained.

Despite many attempts, I found it impossible to devise any method for preserving the outside of the tube as this was naturally contaminated in passing through the mouth. It is, however, questionable if the

results obtained were in any way affected by this, as in all cases the mouth was carefully treated beforehand, and the gastric juices were probably sufficient to, at least, inhibit the majority of bacteria.

A SELECTION OF CASES TREATED BY MEANS OF DUODENAL DRAINAGE AND LAVAGE.

The following cases are selected from a large number which I have treated by means of duodenal drainage and lavage. In all the duodenal contents yielded heavy growths of bacteria.

Case 1. Mrs. R.B. Aged 59.
This patient had been in poor health for several years, suffering from recurrent attacks of dyspepsia and epigastric discomfort. She was of very unhealthy appearance and, on examination, was found to be definitely tender over the gall-bladder. She was very depressed and very constipated. A culture from the duodenum gave an exceptionally heavy growth of bacillus coli and staphylococci. Duodenal drainage and lavage were commenced and continued for seventeen days. At first, the amount of bile recovered did not exceed 100 c.c. in four hours and, it was not until the tenth day that 150 c.c. were recovered. Thereafter her progress was particularly rapid. Her complexion cleared and she was having a daily natural action of the bowels. On the fifteenth day of treatment the amount of bile recovered was 220 c.c. All tenderness in the gall-bladder region had disappeared and, during the past nine months she has enjoyed good health.

Case 2. Mrs. M.C. Aged 42.
This patient gave a history of six years residence in the tropics. She had had typhoid fever. On admission to hospital she was in a markedly debilitated condition, and was profoundly anaemic. Her complexion was muddy in the extreme

and, on examination, she was found to be exceedingly tender in the gall-bladder region. The gall-bladder was probably enlarged, but this could not be definitely ascertained as the liver was enlarged to an extent of three inches below the costal margin. A culture from the duodenum yielded a profuse growth of coliform bacilli, many staphylococci, and an occasional streptococcus. Despite a careful examination on several occasions no typhoid bacilli were ever discovered. The duodenal secretions were loaded with mucus, epithelial debris, and contained occult-blood. In this case I thought it advisable to give a course of duodenal feeding as well as drainage and lavage. The latter was carried out twice daily. For the first three days drainage did not recover more than 80 c.c. of very thick muddy bile but, by the tenth day of treatment, 366 c.c. were recovered during a four-hour drainage. This large amount suggested that the gall-bladder had begun to empty. Her liver now decreased in size and was palpable only one inch below the costal margin, while the bile had resumed a normal appearance. Treatment was continued for twenty-eight days and, at the end, her complexion had entirely cleared; The liver could not be palpated; and there was no tenderness in the gall-bladder region. On discharge she was advised to take large doses of hexamine during alternate weeks for a considerable time and to continue an autogenous vaccine which she had been having during treatment. She has remained well during the past year.

Case 3. Mr. R.H. Aged 43.
This patient was admitted to hospital with a history of increasing tenderness in the gall-bladder region during the previous three weeks. He had had several attacks of jaundice during the past ten years, but there was no trace of this on admission. He complained of severe headaches, loss of sleep, and a bad taste perpetually in his mouth. On examination he was found to have an enlarged gall-bladder which was easily palpated, his tongue was very dirty, and his skin covered with pimples. He was in a thoroughly septic condition. Culture of the duodenal contents showed them to be loaded with coliform bacilli and staphylococci, while the bacillus pyocyaneus was also present. Mucus was very much in excess and scarcely any bile was recovered. Duodenal

drainage and lavage were carried out for twenty days, during which his four-hourly output of bile increased from 28 to 180 c.c. At the time of his discharge his complexion had cleared and his tongue was clean, while his gall-bladder could not be palpated. The change in his appearance was so remarkable that some of his friends did not recognise him. He has remained in good health during the past fourteen months.

Case 4. Mr. I.W. Aged 40.
When this patient, who had returned from Burma one month previously, came to see me he was in an emaciated condition, with a hectic flush, and was running an intermittent temperature. He had had his gall-bladder drained some two years previously but had derived little benefit from the operation. Examination of his duodenal secretions showed a great increase in mucus, the presence of blood, much epithelial debris, and only a trace of bile. Culture showed bacillus coli to be present in one of the heaviest growths I have ever seen, staphylococci, and many streptococci. The gall-bladder could not be palpated but his liver was palpable three inches below the costal margin. Duodenal drainage and lavage were commenced and, during the first day, only 18 c.c. were recovered in four hours. Great difficulty was experienced owing to the thickness of the mucus present but, by the fourth day, 56 c.c. were recovered during four hours. On the fifth day some 10 c.c. of pus came away and thereafter a rapid improvement commenced while the next day the temperature had dropped to normal. Treatment was continued for twenty-three days and at the end as much as 190 c.c. were being recovered. His liver had decreased in size but remained one inch below the costal margin. During the twenty-three days' treatment he gained eight pounds in weight. He returned to Burma a year ago and has written to say that during this time he has kept well except for one slight attack of pain in the gall-bladder region. When he felt this commencing he gave himself a short course of duodenal drainage and lavage with satisfactory results.

Case 5. Mrs. C.M. Aged 32.
This patient was admitted to hospital with severe cardiac failure due to mitral disease. She was cyanosed, had a rapid pulse, oedema of the feet, and congestion at the lung bases. On the eleventh day after admission an attack of acute cholecystitis supervened. The patient complained of acute pain in the right hypochondrium; this was associated

with a rise of temperature and was followed by jaundice. The distended gall-bladder could be readily palpated. Owing to the seriousness of the cardiac condition conservative treatment was deemed advisable. After some improvement during the next week there was a return of the symptoms with increased jaundice and a further rise in temperature. A duodenal tube was passed and a very small amount of foul-smelling bile recovered, which, on microscopical examination, was found to contain pus. It was then decided to give her a course of duodenal lavage and drainage. For the first four days, representing sixteen hours drainage, only a total of 76 c.c. were recovered. Thereafter there was a steady increase in the flow of bile and on the tenth day 96 c.c. were recovered. During this period the temperature subsided by lysis. Treatment was continued for twenty-one days and at the end of this period as much as 226 c.c. were recovered while all local tenderness had ceased and the gall-bladder was no longer palpable. During a further stay of two months in hospital she had no return of any gall-bladder symptoms. She has not reported since discharge. This case was one of particular interest for I had never before attempted to treat any acute gall-bladder condition with the duodenal tube, and indeed, it was only because surgical interference was quite out of the question in this case that I consented to do so.

Case 6. Mr. T.S. Aged 50.
For the previous nine months this patient had complained of "indigestion after meals", associated with nausea, vomiting, and flatulence. There were occasional attacks of diarrhoea. He had been under medical treatment for gastritis during the six months previous to admission to hospital without improvement. He was unable to carry through a week's work without absenting himself for one or two days. He was poorly nourished and on examination was found to be tender over the gall-bladder region. It was thought that he might be a duodenal ulcer, but an X-ray examination showed no deformity of the duodenal cap and the stomach also appeared to be normal. A culture from the duodenal secretions gave a heavy growth of staphylococci and, it was decided to give him a course of duodenal drainage and lavage. On the first day of this treatment only 85 c.c. of bile came away and the amount of mucus was greatly increased. On the fourth day

of treatment 130 c.c. were recovered and he professed to be feeling much easier. On the seventh day all tenderness in the gall-bladder region had disappeared. Treatment was continued for eighteen days and at its close 214 c.c. of bile were recovered in four hours. During treatment he gained four pounds in weight. He has remained in good health for eight months and has not once absented himself from work during this period.

Case 7. Mr. R.J. Aged 48.
This patient had, for several months, suffered from attacks of slight jaundice which generally lasted for two or three days and were always accompanied by epigastric pain in a mild degree. He had always treated himself but the present attack had not yielded to his usual lines of treatment. He had no temperature and his general condition was excellent but, on examination his gall-bladder was found to be easily palpable and, indeed, its outline could be made out, hanging down like a large pear below his ribs. A duodenal tube was passed and drainage and lavage commenced. Very little bile was recovered, and the greatest difficulty was experienced owing to the tube repeatedly becoming choked. This was dealt with successfully until the third day, when every endeavour to clear the tube failed and it was withdrawn for examination. I found it to be choked for a length of several inches with exceptionally dense mucus, while, hanging from the nozzle, was a foul-smelling string of mucus about three inches long. I am convinced that this mucus was virtually a cast of the common bile-duct for, on the tube being re-introduced, it was found that bile was flowing freely. Unfortunately, in this case, the amount of bile recovered could not be estimated for, the flow was so free that the receptacle provided proved inadequate and a considerable proportion of the fluid was lost on the floor. The gall-bladder subsided within three hours, and he was discharged a few days later. He promised to return if there was any renewal of symptoms but, during the past twelve months, he has not done so.

Case 8. Mrs. R.D. Aged 52.
This patient gave a history of an operation for gall-stones some ten years previously. Since then she had had slight attacks of jaundice at

intervals of about nine months. These attacks had been getting more severe and, at the time I saw her, she had been jaundiced ten days. She was of very unhealthy appearance and was experiencing the greatest difficulty in keeping the bowels open. On examination, her liver was enlarged to two finger-breadths below the costal margin and she was rather inclined to resist examination in the gall-bladder region. I had her X-rayed for gall-stones with a negative result. Her van den Bergh reaction was immediate direct. It was decided to give her a course of duodenal drainage and lavage and during the first four hours drainage only 45 c.c. of bile were recovered. Mucus was present in excess and, on microscopical examination many tall columnar epithelial cells were seen. Culture gave a heavy growth of coliform bacilli. The jaundice commenced to fade on the seventh day of treatment and by that time 108 c.c. were recovered in four hours. Treatment was continued for twenty-one days and, at its end 205 c.c. of bile were recovered in four hours, she was having a normal daily action of the bowels and the liver had receded to one finger-breadth below the costal margin. She has remained well during the past ten months.

Case 9. Miss S.L. Aged 39.
This patient had had occasional attacks of jaundice during the previous two years. When I saw her she was definitely jaundiced but had no other symptoms, and said she felt well. On examination the liver was enlarged to two finger-breadths below the costal margin. There was no local tenderness. A culture from the duodenal secretions showed a heavy growth of coliform bacilli, and many staphylococci. Mucus was present in excess. She was considered to be a case of duodenitis and cholangitis and was given a course of duodenal drainage and lavage. The initial four-hour flow of bile amounted to 68 c.c. and, by the end of the first week this had increased to 165 c.c. Treatment was continued for fourteen days and, at its end, 220 c.c. were recovered in four hours. The liver had decreased in size and was only just palpable. She has had no attack of jaundice during the past year, and her weight has increased by twenty-two pounds.

Case 10. Mr. J.E. Aged 47.
This patient had been operated on for gall-stones two years previously but, had had several attacks of jaundice since this operation. During one of these attacks he had been seized with very severe

abdominal pain and since then the jaundice had become much worse, being practically constant although varying in degree. He had been losing weight rapidly owing to the limitations in his diet. Another attack of acute pain had followed and he was again operated on. The surgeon reported that the gall-bladder could not be found and that the right hypochondrium was filled with a dense mass of adhesions. I first saw him three months after this second operation, when he was deeply jaundiced and very emaciated. A duodenal tube was passed and, after many attempts, entered the duodenum. The duodenal contents were loaded with mucus and epithelial debris of every description. Culture gave a heavy growth of coliform bacilli, staphylococci, and several streptococci. The amount of bile recovered by drainage was only a few c.c.. It was found that the ordinary lavage caused considerable pain and consequently the drip-method was substituted. This was continued for a week, when it was found that he could now tolerate the ordinary lavage. At this time the amount of bile recovered was 22 c.c. in four hours. Treatment was continued for twenty-eight days, during which time the amount of bile recovered gradually increased until 140 c.c. were reached. His general condition had improved considerably but a slight degree of jaundice always persisted. The mucus, and epithelial cells had disappeared from the duodenum, and the stool was normal in colour. It was felt that further improvement, owing to the masses of adhesions present, was unlikely but, one hoped that, having relieved the inflammation in the duodenum, bile-ducts, and gall-bladder, his discomfort would be considerably relieved and his general health would improve. This has proved to be the case and, while he is always slightly jaundiced, the exacerbations have been absent during the past fifteen months.

These cases illustrate the benefits which are to be derived from duodenal drainage and lavage.

It will be noted that, with one exception, the progress in each case was gradual, and, I believe that one of the first essentials to be aimed at in the treatment of all cases is the elimination of the, almost

constant, excess of mucus.

The chief value of this lavage and drainage (which should invariably be combined) is undoubtedly the cleansing action of the one, and the elimination of the products of inflammation by the other. Further, apart from its local action on the duodenum and bile-ducts it cannot but help the general well-being of the patient in that it removes from the system a large amount of toxic products which would otherwise be absorbed from the small intestine.

EXAMINATION OF THE PANCREATIC SECRETIONS.

Another instance of the uses to which the duodenal tube may be put is that, by its means, we are able to procure specimens of the pancreatic secretions.

One is, of course, unable to estimate the actual volume of the pancreatic secretion but the presence of the pancreatic enzymes may be readily detected and a diminution in the amount, or absence, of these enzymes is of importance as an aid to diagnosis in a case where pancreatic disease is suspected.

Qualitative tests.

One of the simplest qualitative tests for the presence of the pancreatic enzymes has been described by Einhorn and is as follows:-

(1) LIPASE.

To test for this enzyme mix together one drop of neutral milk, two drops of water, three drops of duodenal contents which should be rendered neutral, and a small piece of litmus agar. These should be kept in a tube at blood temperature. Should lipase be present the litmus agar will be red within thirty minutes owing to the development of fatty acids.

(2) TRYPSIN.

A small piece of the white of a hard-boiled egg is placed in a specimen of neutralised duodenal secretion and kept at body temperature for several hours. The white of egg disappears in the presence of trypsin.

(3) AMYLOPSIN.

In testing for the presence of diastase a solution of boiled starch or a piece of starch paper is required. The starch paper method is the easier and this should be placed in a small flask containing duodenal secretion and left for one hour at body temperature. A weak solution of iodine is then added to determine the presence of any starch which, if present, gives a blue colour. If erythrodextrin is

present a red colour results.

Quantative analysis.

Pavlov was the first to demonstrate that if, in the dog, the vagus nerve be stimulated a secretion of highly digestive juice is poured out by the pancreas.

Later, Bayliss and Starling showed that when a solution of hydrochloric acid was introduced into any part of the intestine a secretion of pancreatic juice occurred and, from this, it was deduced that the acid, thus introduced, caused some chemical substance in the blood-stream to stimulate the pancreas.

These observers then took a piece of duodenal mucous membrane and pounded it up with dilute hydrochloric acid and, the extract, so obtained, they called "secretin". They found that when this was injected into the blood of an animal pancreatic secretion immediately followed.

Pavlov then suggested that the stimulation produced by the injection of secretin was of a different nature from that resulting from stimulation of the vagus. It was held that while the later secretion was rich in enzymes the former was of a more watery nature.

Later, the work of Mellanby has shown that, in the cat, the pancreas gives a rich secretion of

enzymes after vagal stimulation by means of pilocarpine even although repeated injections of secretin had failed to give any further response.

I have endeavoured, with the aid of the duodenal tube, to carry out similar experiments in the human being and the results obtained will be demonstrated later.

These investigations were carried out on apparently normal, healthy persons and all the tests made were of a quantative nature.

The method employed was that described by Gaultier with certain modifications and is as follows:-

Three Erlenmeyer flasks are required and these should be marked "Trypsin", "Amylase", and "Lipase" respectively.

In the "Trypsin" flask place 5 ccm of a five-per-cent. solution of gelatine; in the "Amylase" flask 20 ccm of a five-per-cent. solution of starch; and in the "Lipase" flask, 5 ccm of a twenty-per-cent. emulsion of olive oil.

To each flask add one drop of phenolpthalein solution (one-per-cent. alcoholic solution), and also 1 ccm of duodenal fluid.

Next, add to each flask, drop by drop, N/10 NaOH until a pink colour is produced which persists on shaking.

To the "Amylase" flask add, drop by drop, N/10 H_2SO_4 until the first disappearance of the pink colour.

Incubate the flasks at body temperature for one hour.

After removal from the incubator add a small amount of sodium carbonate to the "Amylase" flask to stop digestion, and place the "Trypsin" and "Lipase" flasks in ice water.

Control flasks containing boiled duodenal fluid, along with gelatine, starch, and oil, must also be prepared as above and incubated with the three test flasks.

"TRYPSIN" ACTIVITY. To the "Trypsin" flask add 5 ccm of neutral formol-alcohol solution, and titrate to a light pink with N/10 NaOH. From the burette-reading subtract the control reading.

The result is a measure of the peptones, amino-acids, etc., formed by the action of trypsin contained in 1 ccm of duodenal fluid upon 1 gram of gelatin.

"LIPASE" ACTIVITY. To the "Lipase" flask add 10 ccm of neutral alcohol-ether solution and titrate to neutrality with N/10 NaOH. The burette-reading is taken and the control reading subtracted.

The result is a measure of the fatty acids formed by the action of 1ccm of duodenal fluid upon 1 ccm of Olive oil for one hour at body temperature.

"AMYLASE" ACTIVITY. The contents of the "Amylase" flask are poured into a burette and run, drop by drop, into 5 ccm of Benedict's reagent to which a little sodium carbonate has been added and which has been heated to boiling point, until the blue colour disappears. The burette-reading divided into 0.0149 (the number of grams of maltose required to reduce 5 ccm of Benedict's reagent) gives the amount of maltose in 1 ccm of the contents. Multiply by 20 to obtain the total amount of maltose formed.

In all the charts which follow trypsin is shown in red, lipase in black, and amylase in green.

Chart No. 1 shows the average amount of pancreatic enzymes recovered from three apparently normal persons who had been starved for twelve hours previous to the experiment. No stimulant, unless the duodenal tube be regarded in that light, was used, and the experiment was continued over a period of one hour.

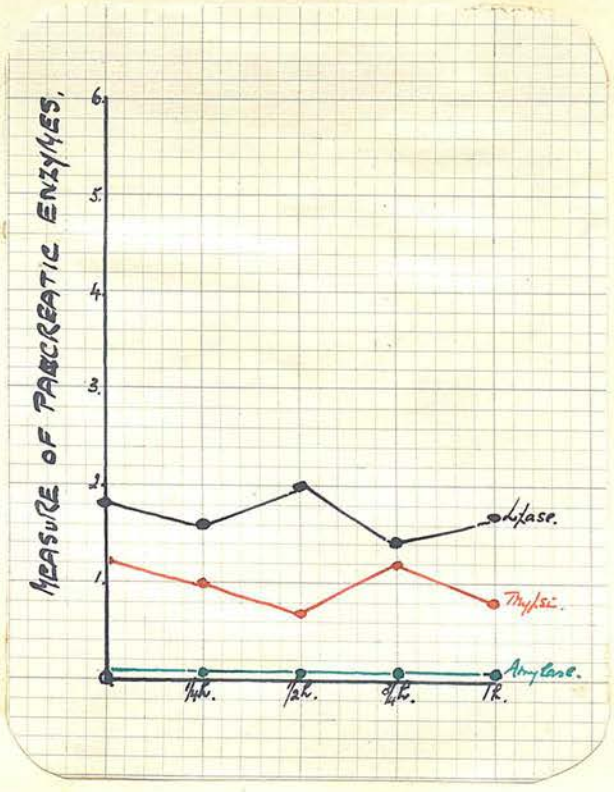


Chart No. 1.

Chart No. 2 illustrates the amount of pancreatic enzymes recovered after the injection of 5 ccm of secretin into an apparently normal person.

It will be noted that, when compared with Chart No. 1 there is a very slight increase in the secretion of trypsin and lipase during the first half-hour, and that thereafter a decline occurs to what may be assumed to be normal. As is shown in Chart No. 1 amylase was present in too small quantities to be estimated.

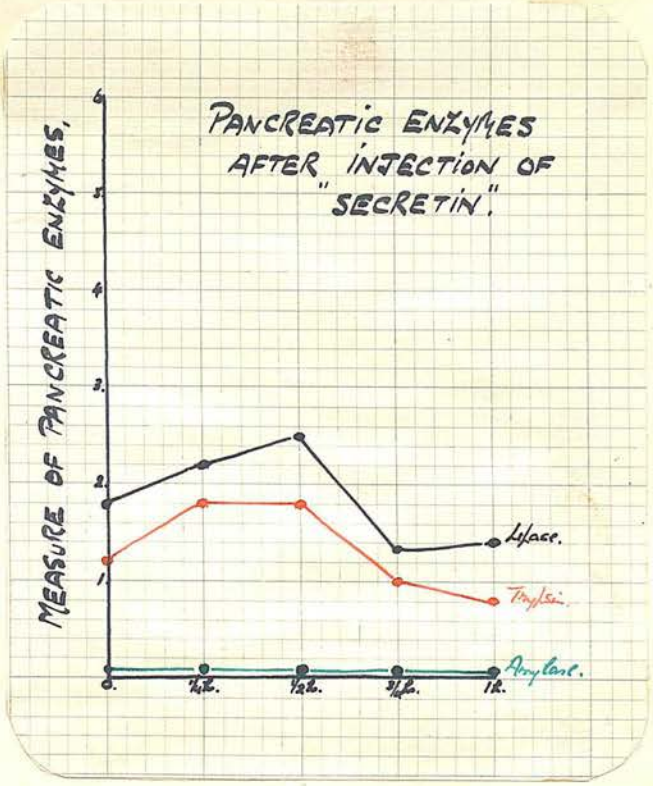


Chart No. 2.

Chart No. 3 shows the amount of pancreatic enzymes recovered after the injection of $\frac{1}{4}$ grain of pilocarpine.

It demonstrates a very considerable increase in the secretion of trypsin and lipase, the former shooting up over the later during the first quarter-of-an hour while, after half-an-hour, the curve drops very precipitately. It is again perhaps worthy of note that the secretion of amylase is negligible.

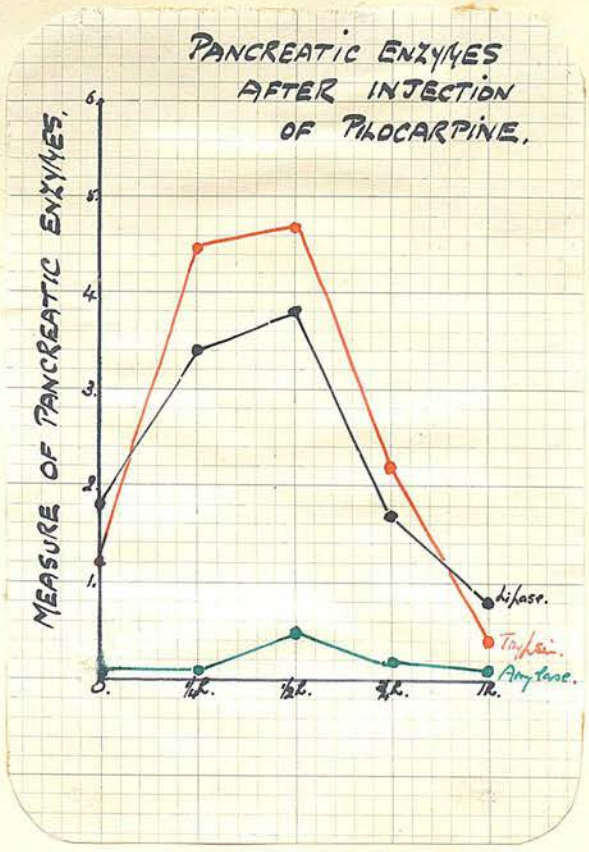


Chart No. 3.

These results would appear to indicate that the pancreas, in the human being, may be stimulated by both nervous and chemical means. In the former it is assumed that the pilocarpine stimulates the nerve endings of the vagus.

The findings would certainly tend to confirm the experiments of Mellanby with the cat in that vagal stimulation in the human subject also produces a marked increase in the enzyme secretion.

The injection of secretin is followed by a markedly milder secretion of enzymes and it may well be that it also, in man, produces an increased secretion of a different type. I have, however, been unable to devise any means of determining this, nor have I been able to detect any chemical changes or difference of specific gravity in the duodenal contents following the injections.

THE SECRETION OF PANCREATIC ENZYMES AFTER STIMULATION BY NORMAL FOODS.

These experiments were carried out on a healthy person, and the results are shown on Chart No. 4. The stimulants used were:- one-and-a-half ounces of fat, protein, and carbohydrate respectively. Each was the subject of a separate experiment, and three days were allowed to elapse between each experiment while on each occasion the subject was starved for twelve hours prior to the test.

It will be noted in Chart No. 4 that the response shown by lipase to fat produces much the highest curve, and it is interesting to note that its response to protein actually slightly exceeds that of trypsin to the same stimulant. The curve of lipase rises very abruptly in every instance.

Trypsin shows a sharply rising curve up to one hour after protein stimulation and then falls rather rapidly. The trypsin curves following carbohydrate and fat stimulation are more gradual and the response to carbohydrate reaches a higher level than to fat but it is not maintained for so long.

Amylase gives its chief response to carbohydrate stimulation, a slightly lower response to fat, and a practically negligible result to protein.

It is noted that all reach a "peak" at one hour with the exception of lipase after stimulation with protein which "peaks" in half-an-hour.

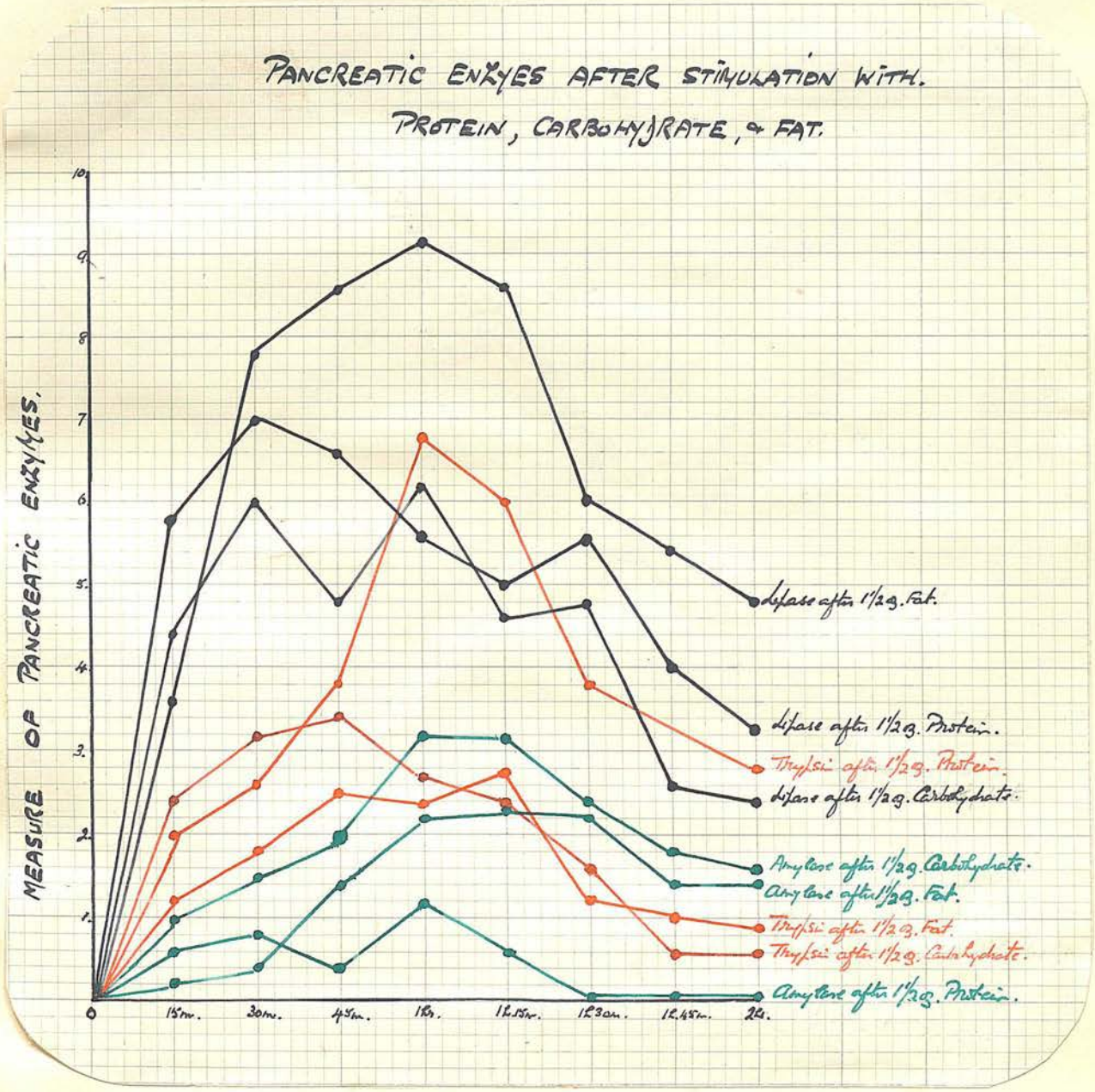


Chart No. 4.

By means of Chart No. 5 I have illustrated the response in the secretion of pancreatic enzymes to stimulation by a mixed diet viz: one-and-a-half ounces each of protein, carbohydrate, and fat.

The subject of this test was the same person from whom the results shown in Chart No. 4 were obtained.

Here again it will be noted that following the mixed diet the lipase curve rises more abruptly than the others but, maintains its "peak" for only one-quarter-of-an-hour and then falls very precipitately.

The trypsin curve also rises sharply, slightly more so than in Chart No. 4, during the first hour, and continues its "peak" for thirty minutes before falling.

Amylase rises more gradually to reach its "peak" in seventy-five minutes.

It will be noted that the curves of all three enzymes are slightly lower in comparison with their maximum response when the various stimulants were given separately.

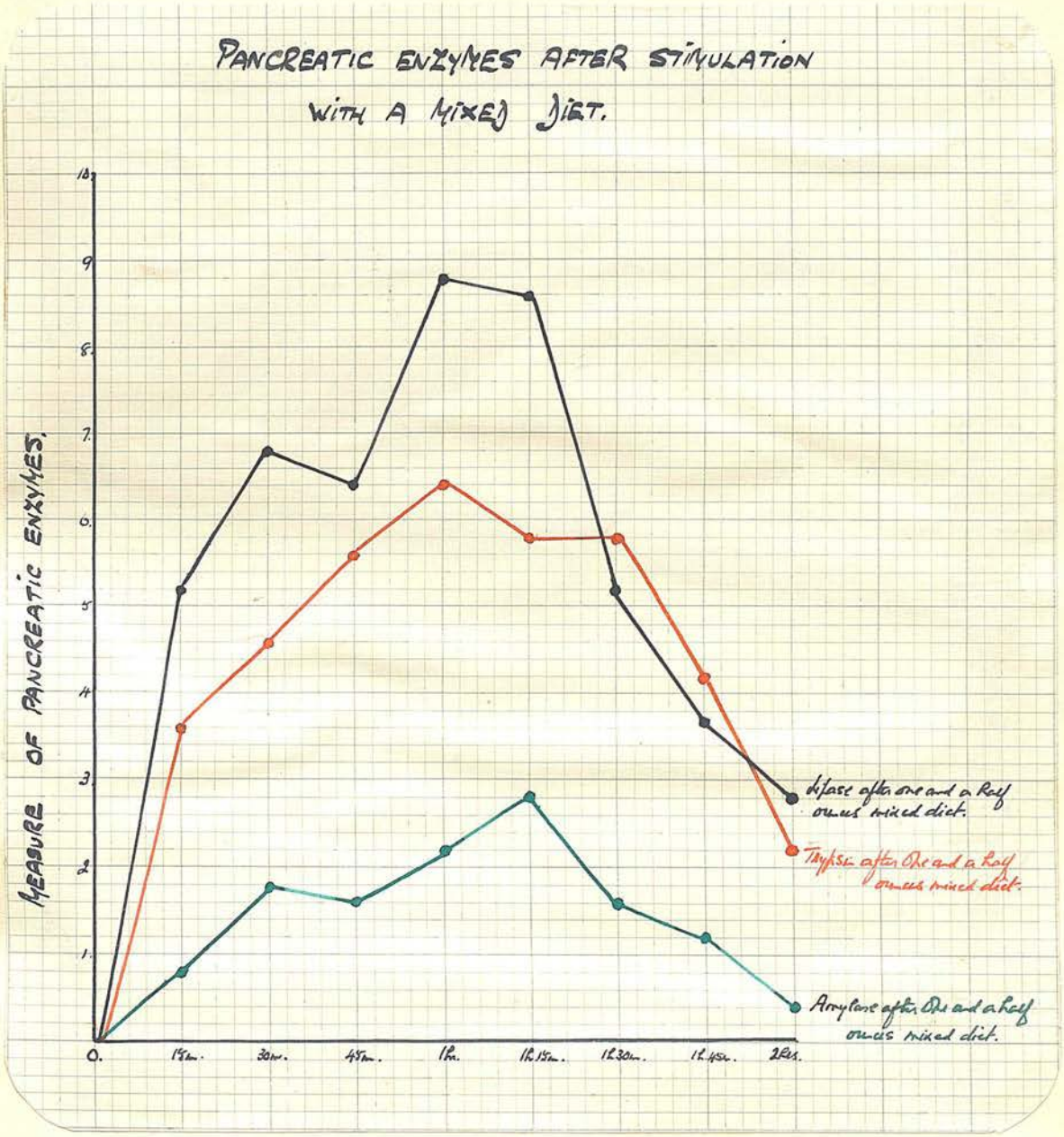

PANCREATIC ENZYMES AFTER STIMULATION
WITH A MIXED DIET.
MEASURE OF PANCREATIC ENZYMES.
10
9
8
7
6
5
4
3
2
1
0.
15m.
30m.
45m.
1h.
1h.15m.
1h.30m.
1h.45m.
2hrs.
Lipase after One and a Half ounces mixed diet.
Trypsin after One and a Half ounces mixed diet.
Amylase after One and a Half ounces mixed diet.

Chart No. 5.

THE EFFECT OF ADRENALIN UPON THE SECRETION OF PANCREATIC ENZYMES.

The adrenalin test of Loewi is one which is based upon the antagonistic action existing between the adrenal glands and the pancreas. It is, briefly, that if two minims of a one-in-a-thousand solution of adrenalin be introduced into the eye the pupil does not dilate unless there be a pancreatic lesion present.

I felt that it would be of interest to demonstrate the effect of this antagonism between the adrenal glands and the pancreas on the secretion of the pancreatic enzymes, and Chart No. 6 shows the curves obtained in the same healthy person as was the subject of the previous pancreatic experiments.

The pancreas was stimulated with half-an-ounce each of protein, carbohydrate, and fat, while a subcutaneous injection of four minims of a one-in-a thousand solution of adrenalin was given exactly half-an-hour afterwards.

In Chart No. 6 I have, for convenience, reproduced Chart No. 5 in dotted lines so that the effect of the adrenalin may be the more easily observed.

It will be noted that in the forty-five-minute specimen all the curves have fallen very sharply but, with the exception of amylase which was not found for a period of half-an-hour, the secretion of enzymes never entirely ceased.

All tend to rise slightly towards the end.

No rise in blood-pressure took place following the injection of adrenalin.

These results indicate that adrenalin does cause a very marked decrease in the secretion of pancreatic enzymes.

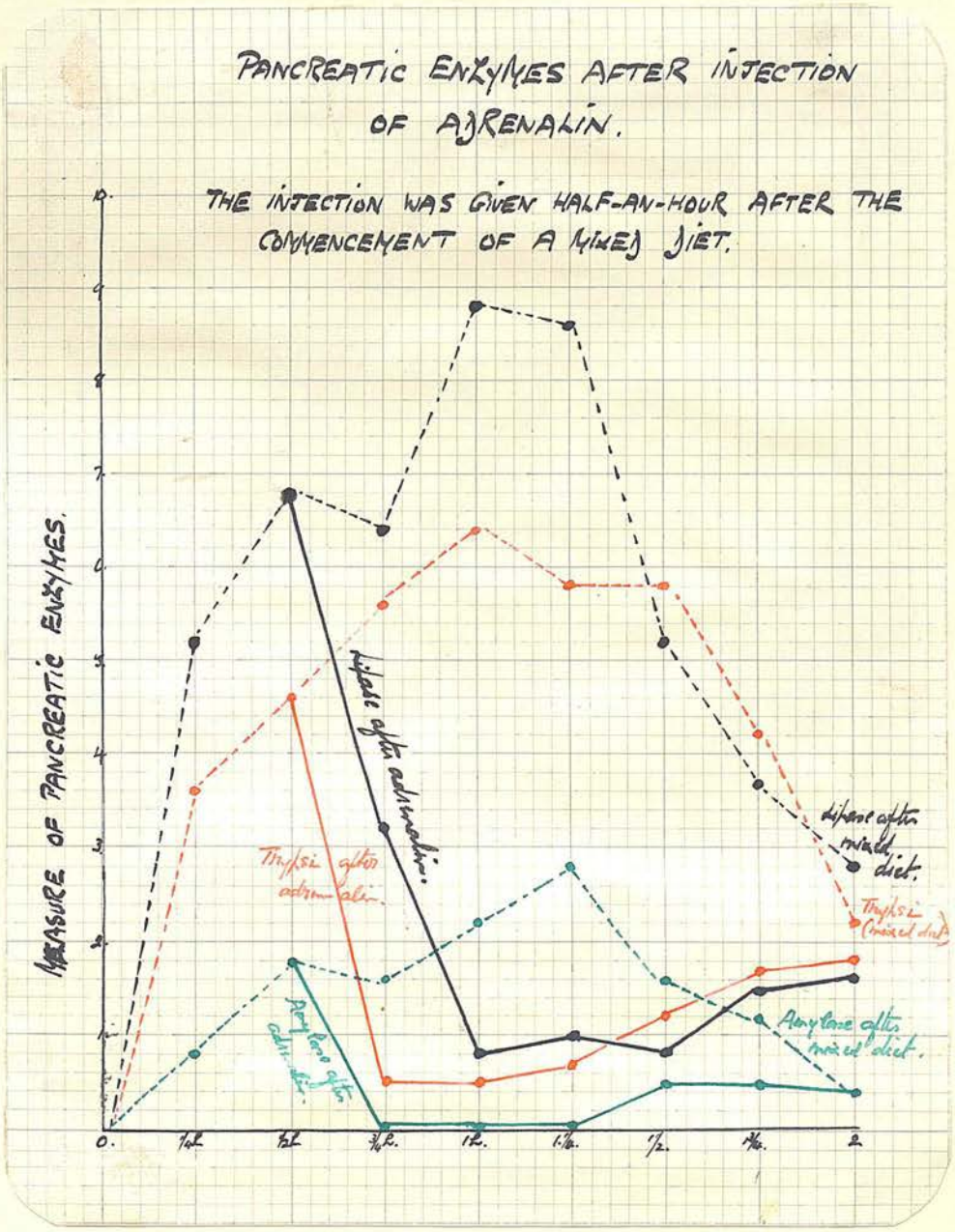


Chart No. 6.

FURTHER PANCREATIC INVESTIGATIONS.

A considerable number of experiments were carried out in cases of diabetes, glycosuria, pernicious anaemia, in an endeavour to ascertain if there were any definite changes present in the secretion of the pancreatic enzymes in these diseases but the results varied in such a marked degree that they appeared quite useless.

Experiments were, however, made in connection with the excretion of diastase in the urine and its relationship to the pancreatic enzymes and, here, results were obtained which appeared to be of definite clinical significance.

Chart No. 7 illustrates the secretion of pancreatic enzymes, after stimulation with a mixed diet, in the case of a patient who had for years suffered from dyspepsia and occasional slight attacks of jaundice which were always accompanied by abdominal pain of a colicky nature and sickness which generally lasted for several days. She was thought to be suffering from gall-stones but was X-rayed with negative results. Her diastatic index was fifty and her case was finally regarded as one of duodenitis associated with mild pancreatitis. She was treated by duodenal lavage and at the end of a fortnight was much improved. At the end of treatment her diastatic index had dropped to twenty-two.

Her chart shows a definite decrease in enzymes when it is compared with the chart from a healthy person (No. 4). Chart No. 7 was plotted at a time when the patient's diastatic index was fifty, while the red dotted-line shows the increased secretion of trypsin at the end of treatment and when the diastatic index had dropped to twenty-two.

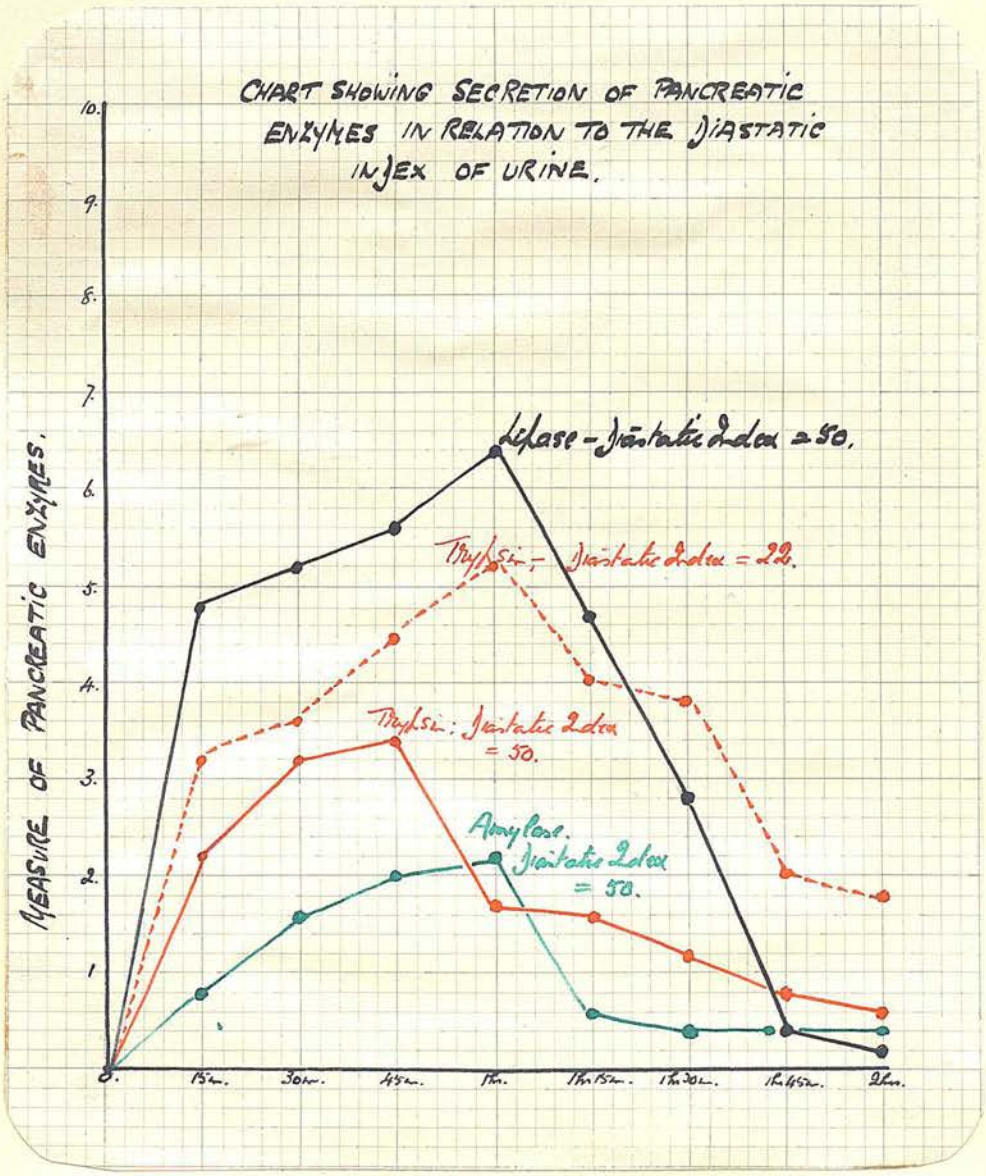


Chart No. 7.

Chart No. 8 was plotted from a patient who had suffered from epigastric pain for three months and had been treated for gastric ulcer. He stated that he improved for a few days at a time but always relapsed. X-ray examination showed no evidence of ulcer. On examination he was tender in the mid-abdominal line, and his urine was found to contain a trace of sugar. His diastatic index was seventy-five and his case was considered to be one of mild pancreatitis of a chronic type. He was treated for a period of three weeks with large doses of urotropine and duodenal lavage on alternate days and improved very rapidly. At the end of treatment his diastatic index had dropped to forty-four.

This chart shows an even greater decrease in the secretion of pancreatic enzymes than No. 7 where the diastatic index was fifty compared with seventy-five in this case.

The trypsin curve after treatment is again shown by a red dotted-line and was plotted at a time when the diastatic index was forty-four. It shows a slight increase but, on the whole, corresponds closely to the trypsin curve on No. 7 chart at the time when that patient's diastatic index was fifty.

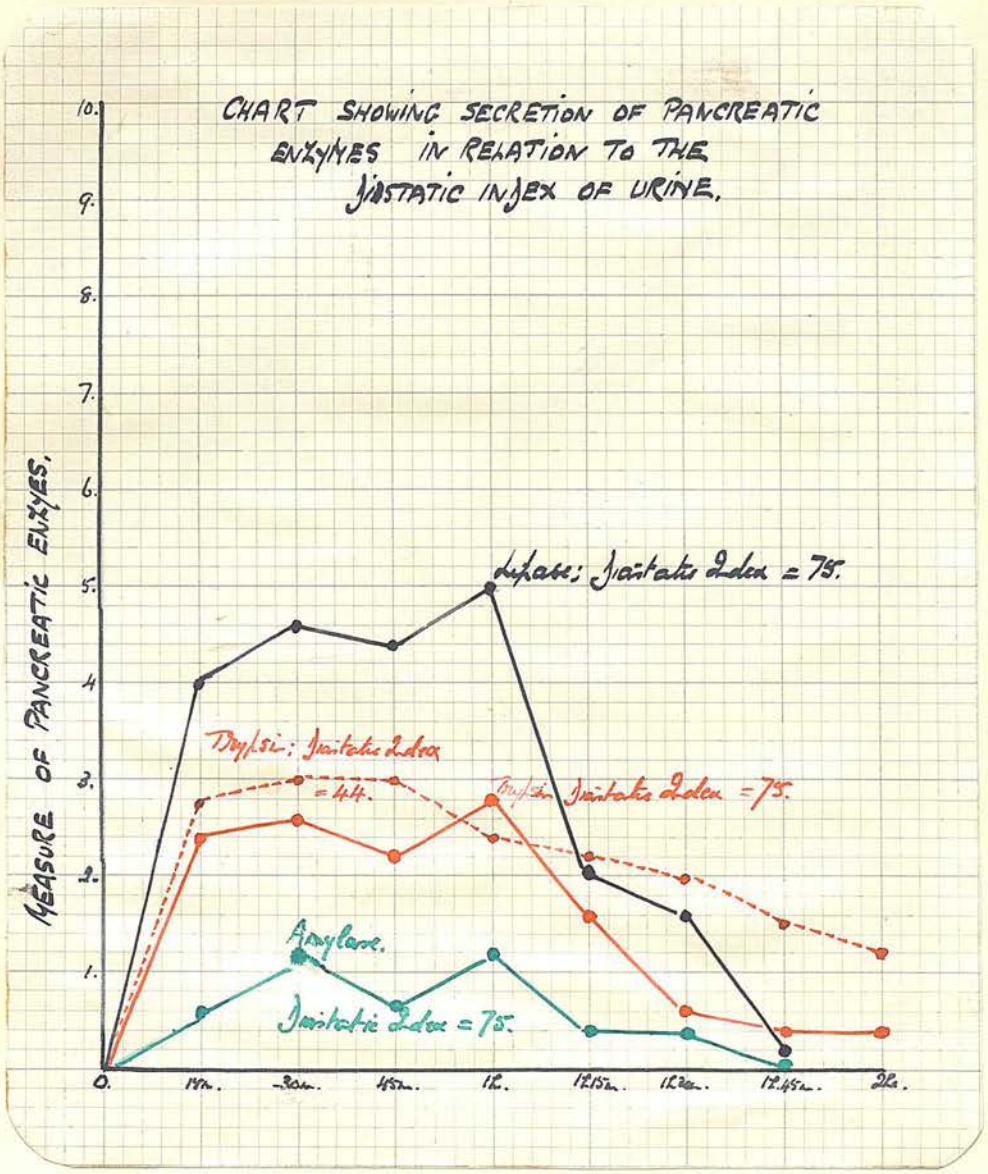


CHART SHOWING SECRETION OF PANCREATIC ENZYMES IN RELATION TO THE JODSTATIC INDEX OF URINE.
MEASURE OF PANCREATIC ENZYMES.
10.
9.
8.
7.
6.
5.
4
3.
2.
1.
0.
Lipase: Jodstatic Index = 75.
Trypsin: Jodstatic Index = 44.
Trypsin Jodstatic Index = 75.
Amylase.
Jodstatic Index = 75.
1Hr.
1.30m.
1.45m.
2Hr.
2.15m.
2.30m.
2.45m.
3Hr.

Chart No. 8.

Chart No. 9 illustrates the enzyme curves from a patient, fifty-two years of age, who had complained of gastric pain and rapid loss of weight for two months. He stated that at times the pain was very intense. He was slightly jaundiced and his complexion dusky. The diastatic index was one-hundred-and-forty, and he was diagnosed carcinoma of the pancreas. His general condition deteriorated rapidly and, within one-fortnight his diastatic index had risen to two-hundred-and sixty, while, at the same time no pancreatic juices were recovered by duodenal intubation. The diagnosis was confirmed at a post-mortem examination.

The chart was plotted at a time when the diastatic index was one-hundred-and-forty and, when compared with charts 7 and 8 shows that the secretion of enzymes has fallen still further.

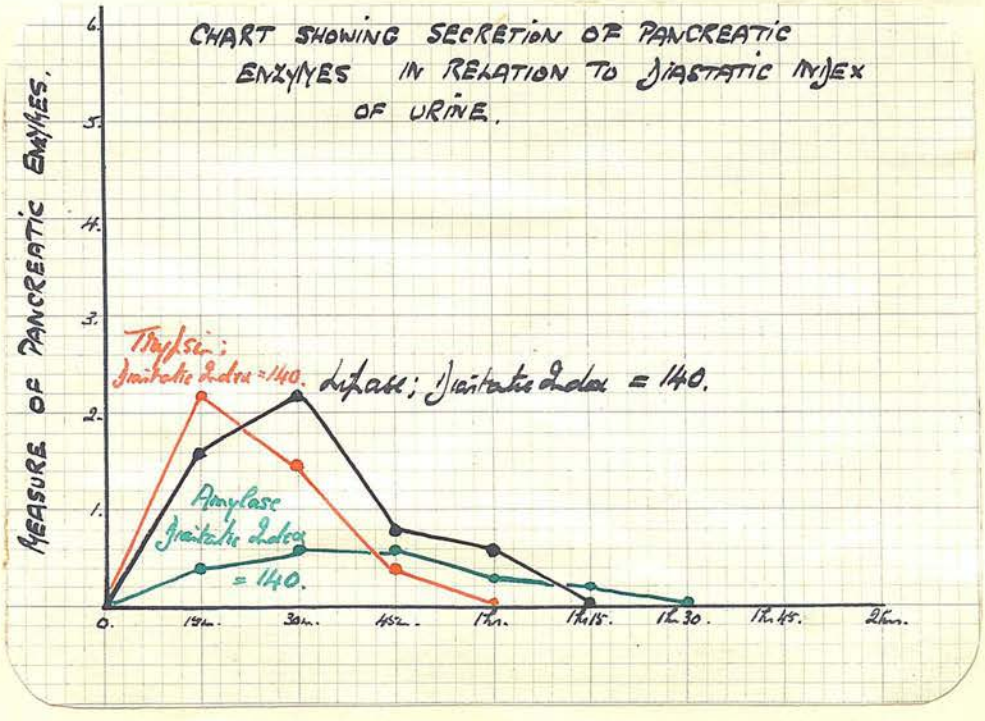


Chart No. 9.

In reviewing these three charts one is struck by the progressive diminution of the secretion of pancreatic enzymes in relation to the increase in the diastatic index, and, further, in charts Nos. 7 and 8 the converse is equally evident in that, after treatment, when the diastatic index had fallen, the secretion of enzymes had risen.

My experience has led me to believe that mild forms of pancreatitis exist with more frequency than is commonly supposed. Certainly, during the past three years, apart from acute pancreatitis, and not even always then, I have never seen a case sent into hospital with a diagnosis of pancreatitis. I believe that frequently the stomach is blamed, when in reality the causal factor lies in the pancreas. This has so impressed me that I now have the diastatic index taken in every doubtful gastric case.

Further, the diastatic index of urine furnishes information regarding the condition of the pancreas in cases of chronic gastric ulcers when these are either adherent to, or, burrowing into the pancreas. It also provides a means of gauging the progress in healing of such ulcers during treatment.

Case M.C. Aged 47.
This patient had a large juxta-pyloric ulcer. Before treatment the diastatic index was 75; after three weeks treatment it had dropped to 35 and, three months later, was 28.

Case A.S. Aged 39.
Had suffered from gastric ulcer for eight years. The present attack, of three weeks duration, was the worst he had ever had. The diastatic index was 90. One month later this had decreased to 46 and, after a further two weeks treatment was 40.

Case R.N. Aged 42.
This patient gave a history of chronic duodenal ulcer. The diastatic index was 85. At operation a large ulcer was found at the pylorus. This ulcer was burrowing into the pancreas. Gastro-jejunostomy was performed. Five weeks later the diastatic index had fallen to 55.

Case A.J. Aged 39.
Had suffered from gastric ulcer for many years. Complained of symptoms suggestive of pyloric stenosis. Diastatic index was 55. Operation disclosed a large chronic ulcer involving the pylorus and burrowing into the pancreas. A gastro-jejunostomy was performed and, six weeks after the operation, the diastatic index had fallen to 25.

Case C.E. Aged 38.
This patient, on X-ray examination, was found to have considerable deformity of the duodenal cap. The diastatic index was 66. After three weeks treatment it had dropped to 40 and, two months later was 32.

A LIVER EFFICIENCY TEST IN WHICH THE DUODENAL TUBE IS EMPLOYED.

On page sixty-four of the second volume of the Extra Pharmacopoeia (1929) Martindale quotes the following:-

> "In the stools of nine out of twenty-six patients after intravenous injection of six mgr. of phenolsulphonephthalein, one to eight per cent. of the amount injected was recovered, showing that the dye may be eliminated, resorbed, and transformed in the digestive tract. The duodenal tube, immediately after the injection, showed presence of one to three per cent. of the dye in the bile of three normals, while it was absent in the bile of five persons with liver disease - Comptes Rend., per Jl. A.M.A. ii/25, 309".

The above is itself an abstract of an original article which appeared in a French journal, and, unfortunately, I have been unable to procure this.

H. G. Mogena, in the Archivos de Medicina Cirugia Y Especialidades of 17th May, 1930 also makes reference to this test as a means of estimating liver efficiency.

Lately, I have carried out a short series of investigations concerning this and find that my results vary in a considerable degree, and differ somewhat from those quoted above.

The technique I employed was as follows:-

The duodenal tube was passed in the usual manner and biliary drainage commenced. When this was

well established an intravenous injection of six mgr. of phenolsulphonephthalein, prepared in "Sterule" form, was given, and the flow of bile was carefully watched for the appearance of the dye. All the experiments were carried out on two occasions in each case with an interval of four days between. On the first occasion the normal flow of bile was studied, while on the second, observations were made after the flow of bile had been stimulated by means of magnesium sulphate solution, introduced into the duodenum immediately before the injection of phenolsulphonephthalein was given.

The table below shows the results obtained:-

Type of case	Period of time elapsing after intravenous injection of phenolsulphonephthalein and the appearance of the dye in the bile.		
	Case.	Normal flow.	After stimulation with magnesium sulphate solution.
Five healthy persons.	A.	2½ minutes.	2 minutes.
	B.	7½ minutes.	7 minutes.
	C.	10 minutes.	10 minutes.
	D.	12 minutes.	12 minutes.
	E.	Not at all.	Not at all.
Five cases of well-marked catarrhal jaundice.	F.	3 minutes.	3 minutes.
	G.	9 minutes.	8 minutes.
	H.	10 minutes.	10 minutes.
	I.& J.	Not at all.	Not at all.
Three cases of cirrhosis of the liver.	K.	5 minutes.	5 minutes.
	L.& M.	Not at all.	Not at all.

Firstly, it will be noted that the times taken by healthy persons to secrete the dye vary considerably

from two to twelve minutes while, in one instance, an undoubtedly healthy youth, no dye was recovered at all. In none was the dye recovered "immediately after the injection".

Secondly, in cases of catarrhal jaundice, while it is true that the negative results have increased by one, the times of the other three cases differ in nowise from those relating to the healthy cases.

Finally, in three cases of marked cirrhosis of the liver the results were again inconsistent for, although absent in two cases, the dye was recovered in five minutes in the third.

Stimulation with magnesium sulphate solution made little or no difference to the results.

I feel that, from the point of view of estimating liver efficiency, no reliance whatsoever can be placed upon such results. In every instance they differ in the time taken for the dye to appear, and in no group was a uniform result, relating to either the presence or absence of the dye, obtained.

Further, a calculation of the actual amount of dye recovered is of no more assistance. Taking the series of jaundice cases where the type differed little if any in severity, the question still remains as to why the dye should be recovered in only three instances out of five? And again, why it should be found in one

case of cirrhosis of the liver and not in the other two?

It would appear to me that such divergence regarding the results is due more to differences in the individual than to varying degrees of liver efficiency, more especially, as it will be observed that the results obtained from each individual differed scarcely at all despite the fact that there was an interval of four days between each test.

SUMMARY.

(1) A full description of the duodenal tube and the method whereby it is introduced into the duodenum is given (Pages 3 - 10).

(2) The technique employed in duodenal feeding is described (Pages 11 - 21).

(3) Evidence is produced to demonstrate the satisfactory results obtained in the treatment of gastric ulcer by means of the duodenal tube, and these results are supported by X-ray photographs (Pages 25 - 38).

(4) Fractional test-meal charts are shown from cases of gastric ulcer to illustrate the difference in gastric secretion before and after treatment (Pages 39 - 44).

(5) Tables are shown to demonstrate that if fluids be introduced into the duodenum under certain conditions no stimulation of gastric secretion is produced (Pages 22 - 24).

(6) It is remarked that the treatment of duodenal ulcer by means of the duodenal tube does not give satisfactory results and a reason for this is submitted (Page 45).

(7) The technique employed in duodenal drainage and lavage is described (Pages 46, 52 and 54 - 56).

(8) Tables are shown to illustrate that the instillation of potassium permanganate solutions into the duodenum, when conducted over a period of from two to three weeks, appears to cause a definite drop in blood-pressure readings (Pages 46 - 51).

(9) Tables are given illustrating experiments relating to the flow of bile in health and disease, and also after stimulation with various cholagogues (Pages 56 - 60).

(10) Cases are quoted to illustrate the results obtained from treatment by duodenal drainage and lavage in duodenitis, and mild affections of the liver, gall-bladder, bile-ducts, and pancreas (Pages 73 - 79).

(11) It is submitted that, in the duodenal tube we have a valuable aid to diagnosis in diseases of the liver, gall-bladder, bile-ducts, and pancreas; and further, that it furnishes the only means by which it is possible to procure, for purposes of investigation, fresh specimens of the secretions pertaining to, and poured into, the duodenum (Pages 60 - 65, 80 - 84).

(12) The introduction of a sterile tube into the duodenum is described (Page 72).

(13) A brief description of the bacteriological findings relating to the duodenum in health and disease is given (Pages 66 - 69).

(14) Charts are submitted illustrating the secretion of pancreatic enzymes, as recovered by means of the duodenal tube, in response to various food, and other stimuli (Pages 85 - 94).

(15) Attention is drawn to the relationship which appears to exist between the diastatic index of urine and the secretion of pancreatic enzymes (Pages 95 - 101).

(16) Remarks are made concerning the duodenal tube as a means of testing hepatic efficiency (Pages 102 - 105).

(17) Finally, a quotation from Max Einhorn:-

> "In one decade the duodenal tube has shown its great value in the diagnosis as well as in the treatment of a variety of diseases. In a few instances this comparatively new instrument has saved some lives, which otherwise would have been lost.
>
> "The diagnostic possibilities, while already numerous, are far from having been exhausted. It will probably take decades to elucidate all the details of the secretions it makes possible to obtain, in pure form, for analysis.

"Already a number of investigators, here and abroad, have busied themselves with the various problems concerning the duodenum, pancreas, and liver, as can be ascertained by means of the tube. The probability is that the numbers of workers in this field will steadily increase".

Max Einhorn, "The Duodenal Tube".

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